

SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE

NEREIS

BOREALI-AMERICANA

DESCRIPTIONS TO A HISTORY OF THE NEREIS
OF NORTH AMERICA

WILLIAM HENRY HARVEY, M.D., M.R.S.

RESEARCHES ON THE ANATOMY OF THE NEREIS, AND THE NEREIS OF NORTH AMERICA

IN THREE PARTS, WITH MANY COLORED PLATES



PUBLISHED BY THE SMITHSONIAN INSTITUTION

WASHINGTON

AMERICAN COLLEGE OF PHYSICIAN

NEW YORK

BOREALLI-AMERICAN

CONSTITUTIONAL HISTORY OF THE UNITED STATES

WILLIAM HENRY DAVIS, M.D.

OF THE FACULTY OF THE UNIVERSITY OF CHICAGO



WASHINGTON: PUBLISHED BY THE NATIONAL INSTITUTION

AND FOR THE AUTHOR BY THE NATIONAL INSTITUTION

SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE.

NEREIS
BOREALI-AMERICANA:

OR,

CONTRIBUTIONS TO A HISTORY OF THE MARINE ALGÆ
OF NORTH AMERICA.

BY

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IN THREE PARTS, WITH FIFTY COLORED PLATES.



WASHINGTON CITY:
PUBLISHED BY THE SMITHSONIAN INSTITUTION.

MAY, 1858.

NEW YORK: D. APPLETON AND CO.

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DR. JOHN TORREY,

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JOSEPH HENRY,

Secretary S. I.

ADVERTISEMENT.

THIS work has been prepared at the request of the Smithsonian Institution, by Dr. W. H. Harvey, Professor of Botany of the University of Dublin. An invitation a few years ago to deliver a course of lectures on the Algæ before the Lowell Institute of Boston, gave him an opportunity to study the marine botany of the coast of the United States bordering on the Atlantic and Gulf of Mexico. He subsequently made a tour around the shores of the Pacific, and has thus been enabled to describe the sea-plants of Oregon and California.

The work consists of three parts. The first, on *Melanospermeæ*, was published as a memoir in the third volume of the Smithsonian Contributions; the second part, on *Rhodospermeæ*, in the fifth; and the last, on *Chlorospermeæ*, in the tenth volume of the same series.

Copies of these have been distributed to all the principal Libraries and Institutions of the world; and in order to diminish the expense of publication as well as to render the work more generally useful, a number of extra copies have been struck off and the three parts bound together in one volume, to be sold to individuals and institutions which do not fall within the classes of those to whom the Smithsonian Contributions are presented.

The principal object of the Smithsonian Institution, as is clearly indicated in the will of its founder, is the prosecution and publication of scientific researches, and the present work is considered to be strictly in accordance with this design. Without the assurance on the part of the Institution that it would be published, it would not have been undertaken, and the results of the generous devotion to science of the author, in this line, could not have been given to the world.

In reference to the character of the work, and in justice to the Institution as well as the author, we may be permitted to copy the following remarks from a paper published by the late Prof. Forbes, of the University of Edinburgh. "A more proper person than Prof. Harvey could not have been selected for the elaboration of a '*Nereis Boreali-Americana*,' and most honorable is it to the directors of the Smithsonian Institution of North America, that they should have selected this

gentleman for the task of which we have now the first fruits. The trustees of that establishment are pursuing a course which is sure to do much towards the wholesome development of science in the United States. In the present instance they have done what is both wise and generous, and in seeking the best man to do the difficult work they require done, have recognized nobly the truth that science belongs to the world, to all mankind, laboring for the benefit of all regions and races alike."

JOSEPH HENRY,
Secretary S. I.

SMITHSONIAN INSTITUTION,
May 21, 1858.

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SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE.

NEREIS
BOREALI-AMERICANA:

OR,

CONTRIBUTIONS TO A HISTORY OF THE MARINE ALGÆ
OF NORTH AMERICA.

BY

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PART I.—MELANOSPERMEÆ.

ACCEPTED FOR PUBLICATION

BY THE SMITHSONIAN INSTITUTION,

JULY, 1851.

· COMMISSION
TO WHICH THIS PAPER HAS BEEN REFERRED.

PROF. J. W. BAILEY,
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INTRODUCTION.

AMONG the plants which constitute the ordinary covering of the ground, whether that covering be one of forests, peopled by vegetable giants, or of the herbage and small herbaceous plants that clothe the open country, we observe that the greater number—at least of those which ordinarily force themselves on our notice—have certain obvious organs or parts: namely, a *root* by which they are fixed in the ground, and through which they derive their nourishment from the fluids of the soil; a *stem* or axis developed, in ordinary cases, above ground; *leaves* which clothe that stem, and in which the crude food absorbed by the roots and transmitted through the stem is exposed to the influence of solar light and of the air; and, finally, special modifications of leaf buds called *flowers*, in which seeds are originated and brought to maturity. These seeds, falling from the parent plant, endowed with an independent life under whose influence they germinate, attract food from surrounding mineral matter; digest it; *organize* it, that is, convert it from dead substance into living substance; form new parts or organs from this prepared matter; and, finally, grow into vegetables, having parts similar to those of the parent plant, and similarly arranged.

This is the usual course of vegetation: seeds develop roots, stems, and leafy branches; the latter at maturity bear flowers, producing similar seeds, destined to go through a like course; and so on, from one vegetable generation to another. But, with a perfect agreement among seed-bearing plants in the end proposed and attained, there is an endless variety of minor modifications through which the end is compassed. All degrees of modification exist between the simplest and most complicated digestive organs; in some, the root, stem, and leaves are so blended together, that we lose the notion of distinct organs, and in others the leaves are reduced to scales or spines, while the stem and branches are expanded and become not merely leaf-like, but actually discharge the functions of leaves. In the reproductive organs or flowers, too, we find equal variety; from the most elaborate and often gorgeous structures to the simplest and plainest, till at last we arrive at flowers, whose organization is so low that not only have calyx and corolla disappeared, but the very seed-vessel itself is reduced to an open scale or is wholly absent. Yet in all these modifications it is merely the means that are varied; the

end proposed is as efficiently attained by the simplest agency as by the most complex ; as if the Creator had designed to show us plainly how it is the same to Him to act by many or by few, by the most elaborate arrangement when He wills it, and by the simplest when that is His pleasure.

In all the cases of which we have as yet spoken, *seeds* are the result of the vegetable cycle ; a seed being a compound body, containing an *embryo* or miniature plant, having stem, root, and leaf already organized, and enclosed with proper coverings or seed coats. But some plants do not produce such seeds. At least one-sixth of the vegetable kingdom, perhaps more, are propagated by isolated cells (or *spores*) cast loose from the structure of which they had formed a portion, and endowed thenceforth with independent powers of growth and development. Such are the reproductive bodies of the Ferns, the Mosses, and all plants below them in the vegetable scale, concluding with the large class to which our attention will now be confined—the Algæ—which of all are the lowest and simplest in organization.

The framework of every vegetable is built up of *cells*, little membranous sacs of various forms, with walls of varying tenacity, empty, or containing fluid or granular, organized matter, from which new cells may be developed. Among more perfect plants there is, in different parts of the same individual, considerable variety in the form and substance of the cells ; those of the wood and of the veins of the leaves being different from those of the soft part of the leaves, and these again different from those of the skin which is spread over the whole. But as we descend in the scale of organization, greater and greater uniformity is found. Below the *Ferns*, no vascular tissue and no proper wood-cells occur ; and at last in the Algæ, no cells exist differing from those of ordinary parenchyma or soft cells, such as compose the pulp of a leaf. Algæ, then, together with Mosses, Lichens and Fungi, are termed *cellular* plants, in contradistinction to Ferns and Flowering plants, which are denominated *vascular*. Among the most perfect of the Algæ, however, though the cells are all of the same substance and nature, all *parenchymatic*, they are of various forms and arrangement in different portions of the vegetable, often keeping up a very perfect analogy with the double system of arrangement—the vertical and horizontal, or woody and cellular systems—of higher plants. Thus the cells of the axis of the compound cylindrical Algæ are arranged longitudinally, like the wood-cells of stems, while those of the periphery or outer coating of the same Algæ have a horizontal direction.

In the most perfect of such Algæ the frame still consists of *root*, *stem*, and *leaves*, developed in an order analogous to that of higher plants. Passing from such, we meet with others gradually less and less perfect, until the whole vegetable is reduced either to a root-like body, or a branching naked stem, or an expanded leaf ; as if Nature had first formed the types of the compound vegetable organs so named and exhibited them as separate vegetables ; and then, by combining them in a single framework, had built up her perfect idea of a fully organized plant. But among the Algæ, we may go still lower in vegetable organization, and arrive at plants where the whole body is composed of a few cells strung together ; and finally at others—the simplest of known vegetables—whose whole framework is a single *cell*. These are the true vegetable *monads* : with these we commence the

great series of the Algæ at its lowest point, and proceeding upwards we find, within the limits of this same series, all degrees of complication of framework short of the development of proper flowers. It is this progressive organization of the Algæ, which renders the study of this portion of the vegetable world especially interesting to the philosophical botanist, because it displays to him, as in a mirror, something of that general plan of development which nature has followed in constructing other and more compound plants, in which her steps are less easily traced. From its first conception within the ovule to its full development, one of the higher plants goes through transformations strictly analogous to stages of advancement that can be traced among the Algæ from species to species, and from genus to genus, from the least perfect to the most perfect of the group. Each Alga-species has its own peculiar phase of development, which it reaches, and there stops; another species, passing this condition, carries the ideal plan a step further; and thus successive species exhibit successive stages of advancement.

While their gradually advancing scale of development renders the study of these plants more interesting, it also increases the difficulty of constructing a short and yet definite character, or *diagnosis*, which will include every member of the group, and exclude species more properly referable to the kindred groups of LICHENS and FUNGI. I shall not here attempt any such critical definition, but proceed to trace the gradual evolution of the frond and of the organs of fructification in the Algæ, assuming that with the ALGÆ are to be classed all Thallophytes (or Cryptogamic plants destitute of proper axes, in the more restricted view of that term) which are developed in water, or nourished wholly through the medium of fluids, while all Thallophytes that are ærial and not parasitic are LICHENS, and all that are ærial and parasitic are FUNGI.

Commencing then with Algæ of the simplest structure, a large part of them, belonging to the orders *Diatomaceæ* and *Desmidiaceæ*, consist almost entirely of individual isolated cells. Each plant, or frond, is formed of a single living cell; destitute therefore of any special organs, and performing every function of life in that one universal organ of which its frame consists. The growth of these simple plants is like that of the ordinary cells of which the compound frame of higher plants is composed. Nourishment is absorbed through the membranous coating of the young plant (or cell), digested within its simple cavity, and the assimilated matter applied to the extension of the cell-wall, until that has reached the size proper to the species. Then the matter contained within the cavity gradually separates into two portions, and at the same time a cell-wall is formed between each portion, and thus the original simple cell becomes two cells. These no longer cohere together, as cells do in a compound plant, but each half-cell separates from its fellow, and commencing an independent career, digests food, increases in size, divides at maturity, &c., going again and again through a similar round of changes. In this way, by the process of self-division, and without any fructification, a large surface of water may soon be covered with these vegetable monads, from the mere multiplication of a single individual.

These minute plants, (*Diatomaceæ* and *Desmidiaceæ*) from their microscopic size and uniform and simple structure, are justly regarded as at the base of the vegeta-

ble kingdom. Notwithstanding which lowly position in the scale of being, they display an infinite variety of the most exquisite forms and finely sculptured surfaces; so that their study affords as much scope for the powers of observation as does that of the creation which is patent to our ordinary senses. These tribes are however omitted from this essay, because they have been made the objects of special enquiry by Professor Bailey of West Point, whose memoir in the second volume of the Smithsonian Contributions is referred to for further information.

But *Desmidiaceæ* and *Diatomaceæ* are not the only Algæ of this simple structure. The lowest forms of the order *Palmellaceæ*, such as the *Protococcus* or *Red snow plant*, have an equally simple organization. The blood-red colour of Alpine or Arctic snow which has been so often observed by voyagers, and which was seen to spread over so vast an extent of ground by Captain Ross, in his first arctic journey, is due to more than one species of microscopic plant, and to some minute infusorial animals which perhaps acquire the red colour from feeding on the *Protococcus* among which they are found. The best known and most abundant plant of this snow vegetation is the *Protococcus nivalis*, which is a spherical cell, containing a carmine-red globe of granulated, semi-fluid substance, surrounded by a hyaline limbus or thick cell-wall. At maturity the contained red matter separates into several spherical portions, each of which becomes clothed with a membranous coat; and thus forming as many small cells. The walls of the parent whose whole living substance has thus been appropriated to the offspring, now burst asunder, and the progeny escape. These rapidly increase in size until each acquires the dimensions of the parent, when the contained matter is again separated into new spheres; giving rise to new cells, to undergo in their turn the same changes. And as, under favourable circumstances, but a few hours are required for this simple growth and developement, the production of the red snow plant is often very rapid: hence the accounts frequently given of the sudden appearance of a red colour in the snow, over a wide space, which appearance is ascribed by common report to the falling of bloody rain or snow. In many such cases it is probable that the *Protococcus* may have existed on the portion of soil over which the snow fell, and its developement may have merely kept pace with the gradually deepening sheet of snow. That this plant is not confined to the surface of snow is well known; and Captain Ross mentions that in many places where he had an opportunity of examining it, he found that it extended several feet in depth. It has been found both in Sweden and Scotland on rocks, in places remote from snow deposits; and it probably lies dormant, or slowly vegetates in such cases, waiting for a supply of snow in which it grows with greater rapidity.

The structure and developement which I have described as characterizing *Protococcus*, are strikingly similar to those of what are commonly considered minute infusorial animals, called *Volvox*; the chief difference between *Protococcus* and *Volvox* being that the latter is clothed with vibratile hairs, by the rapid motion of which the little spheres are driven in varying directions through the water. Many naturalists, and some of high note, are now of opinion that *Volvox* and its kindred should be classed with the Algæ, and certainly (as we shall afterwards see) their peculiar ciliary motion is no bar to this association. I do not

pronounce on this question, because it does not immediately concern our present subject, and because, in all its collateral bearings, it requires more attentive examination than it has yet undergone.

In *Protococcus* the cell of which the plant consists is spherical or oval; in other equally elementary Algæ the cell is cylindrical, and sometimes lengthened considerably into a thread-like body. Such is the formation of *Oscillatoria*. In *Vaucheria* there is a further advance, the filiform cell becoming branched without any interruption to its cavity; and such branching cells frequently attain some inches in length, and a diameter of half a line, constituting some of the largest cells known among plants.

In all these cases each cell is a separate individual: such plants are therefore the simplest expression of the vegetable idea. But even in this extremest simplicity we find the first indication of the structure which is to be afterward evolved. Thus in the spherical cell we have the earliest type of the cellular system of a compound plant developing equally in all directions; and in the cylindrical cell, the illustration of the vertical system developing longitudinally. These tendencies, here scarcely manifest, become at once obvious when the framework begins to be composed of more cells than one.

Thus in the genera nearest allied to *Protococcus*, the frond is a roundish mass of cells cohering irregularly by their sides. From these through *Palmella* and *Tetraspora* we arrive at *Ulva*, where a more or less compact membranous expansion is formed by the lateral cohesion of a multitude of roundish (or, by mutual pressure, polygonal) cells originating in the quadri-partition of older cells; that is, by the original cells dividing longitudinally as well as transversely, thus forming four new cells from the matter of the old cell, and causing the cell-growth to proceed nearly equally in both directions. Starting, therefore, from *Protococcus*, and tracing the development through various stages, we arrive in *Ulva* at the earliest type of an expanded leaf.

In like manner the earliest type of a stem may be found by tracing the Algæ which originate in cylindrical cells. Here the new cells are formed in a longitudinal direction only, by the bipartition of the old cells. Thus, in *Conferva*, where the body consists of a number of cylindrical cells, strung end to end, these have originated by the continual transverse division of an original cylindrical cell. Such a frond will continually lengthen, but will make no lateral growth; and consisting of a series of joints and interspaces, it correctly symbolizes the stem of one of the higher plants, formed of a succession of nodes and internodes. And the analogy is still further preserved when such confervoid threads branch; for the branches constantly originate at the joints or *nodes*, just as do the leaves and branches of the higher compound plants.

We have then two tendencies exhibited among Algæ—the first, a tendency to form membranous expansions, the symbols or types of leaves; the second a tendency to form cylindrical bodies or stems. Among the less perfect Algæ the whole plant will consist either of one of these foliations, or of a simple or branched stem. But gradually both ideas or forms will be associated in the same individual, and exhibited in greater or less perfection. We shall find stems becoming flattened at

their summits into leaves, and leaves, by the loss of their lateral membranes, and the acquisition of thicker midribs, changing into stems; and among the most highly organized Algæ we shall find leaf-like lateral branches assuming the form, and to a good degree the arrangement of the leaves of higher plants. Not that we find among Algæ proper leaves, like those of phænogamous plants, constantly developing buds in their axils; for even where leaf-like bodies are most obvious (as in the genus *Sargassum*), they are merely *phyllocladia* or expanded branches; as may readily be seen by observing a *Sargassum* in a young state, and watching the gradual changes that take place as the frond lengthens. These changes will be explained in the systematic portion of this work.

I shall now notice more particularly the varieties of habit observed among the compound Algæ, and first,

OF THE ROOT.

The *root* among the Algæ is rarely much developed. Among higher plants which derive their nourishment from the soil in which they grow, and in Fungi which feed on the juices of organized bodies, root-fibres, through which nourishment is absorbed, are essential to the development of the vegetable. But the Algæ do not, in a general way, derive nourishment from the soil on which they grow. We find them growing indifferently on rocks of various mineralogical character, on floating timber, on shells, on iron or other metal, on each other,—in fine, on any substance which is long submerged, and which affords a foothold. Into none of those substances do they emit roots, nor do we find that they cause the decay, or appropriate to themselves the constituents, of those substances. They are nourished by the water that surrounds them and the various substances which are dissolved in it. On those substances they frequently exert a very remarkable power, effecting chemical changes which the chemist can imitate only by the agency of the most powerful apparatus. They actually sometimes reverse the order of chemical affinity, driving out the stronger acid from the salts which they imbibe, and causing a weaker acid to unite with the base. Thus they decompose the muriate of soda which they absorb from sea-water, partly freeing and partly appropriating the chlorine and hydrogen; and the soda is found combined in their tissues with carbonic acid.

A remarkable instance of the action of a minute Alga on a chemical solution was pointed out to me by Prof. Bache, as occurring in the vessels of sulphate of copper kept in the electrotyping department of the Coast Survey office at Washington. A slender confervoid Alga infests the vats containing sulphate of copper, and proves very destructive. It decomposes the salt, and assimilates the sulphuric acid, rejecting (as indigestible!) the copper, which is deposited round its threads in a metallic form. It sometimes appears in great quantities, and is very troublesome; but the vats had been cleaned a few days before I visited them, so that I lost the opportunity of examining more minutely this curious little plant. Most probably it is a species of *Hygrocrocis*,* a group of Algæ of low organization but strong diges-

* Perhaps the *Hygrocrocis cuprica*, Kütz, or some allied species; but I had no opportunity of examining a recent specimen, and the characters cannot be made out from a dried one.

tive powers, developed in various chemical solutions or in the waters of mineral springs. All the Algæ however which are found in such localities are not species of *Hygrocrocis*, for several *Oscillatoria* and *Calothrices* occur in thermal waters. Species of the former genus are found even in the boiling waters of the Icelandic Geysers. Of the latter, one species at least, *Calothrix nivea*, is very common in hot sulphur springs, and I observed it in great plenty in the streams running from the inflammable springs at Niagara.

But on whatever substance the Alga may feed, it is rarely obtained through the intervention of a root. Dissolved in the water that bathes the whole frond, the food is imbibed equally through all the cells of the surface, and passes from cell to cell toward those parts that are more actively assimilating, or growing more rapidly. The root, where such an organ exists, is a mere holdfast, intended to keep the plant fixed to a base, and prevent its being driven about by the action of the waves. It is ordinarily a simple disc, or conical expansion of the base of the stem, strongly applied and firmly adhering to the substance on which the Alga grows. This is the usual form among all the smaller growing kinds. Where, however, as in the gigantic Oar-weeds or *Laminariae*, the frond attains a large size, offering a proportionate resistance to the waves, the central disc is strengthened by lateral holdfasts or discs formed at the bases of side roots emitted by the lower part of the stem; just as the tropical Screw-pine (*Pandanus*) puts out cables and shrouds to enable its slender stem to support the weight of the growing head of branches. The branching roots of the *Laminaria*, then, are merely *Fucus*-discs become compound: instead of the conical base of a *Fucus*, formed of a single disc, there is a conical base formed of a number of such discs disposed in a circle. In some few instances, as in *Macrocystis*, the grasping fibres of the root develop more extensively, and form a matted stratum of considerable extent, from which many stems spring up. This is a further modification of the same idea, a further extension of the base of the cone.

In all these cases the roots extend over flat surfaces, to which they adhere by a series of discs. They show no tendency to penetrate like the branching roots of perfect plants. The only instances of such penetrating roots among the Algæ with which I am acquainted, occur in certain genera of *Siphonæ* and in the *Caulerpeæ*, tropical and sub-tropical forms, of which there are numerous examples on the shores of the Florida Keys. These plants grow either on sandy shores or among coral, into which their widely extended fibrous roots often penetrate for a considerable distance, branching in all directions, and forming a compact cushion in the sand, reminding one strongly of the much divided roots of sea-shore grasses that bind together the loose sands of our dunes. But neither in these cases do the roots appear to differ from the nature of holdfasts, and their ramification and extension through the sand is probably owing to the unstable nature of such a soil. It is not in search of nourishment, but in search of stability, that the fibres of their roots are put forth, like so many tendrils. We shall have more to speak of these roots in the proper place, and shall now proceed to notice some of the forms exhibited by

THE FROND.

The *frond* or vegetable body of the compound Algæ puts on a great variety of shapes in different families, as it gradually rises from simpler to more complex structures. In the less organized it consists of a string of cells arranged like the beads of a necklace; and the cells of which such strings are composed may be either globose or cylindrical. In the former case we have a *moniliform* string or *filament*, and in the latter a filiform or cylindrical one. The term *filament* (in Latin, *filum*) is commonly applied to such simple strings of cells, but has occasionally a wider acceptance, signifying any very slender, threadlike body, though formed of more than one series of cells. This is a loose application of the term, and ought to be avoided. By Kützing the term *trichoma* is substituted for the older word *filum* or filament. Where the *filament* (or *trichoma*) consists of a single series of consecutive cells, it appears like a jointed thread; each individual cell constituting an *articulation*, and the walls between the cells forming *dissepiments* or *nodes*, terms which are frequently employed in describing plants of this structure. Where the filament is composed of more series of cells than one, it may be either *articulated* or *inarticulate*. In the former case, the cells or articulations of the minor filaments which compose the common filament are all of equal length; their dissepiments are therefore all on a level, and divide the compound body into a series of nodes and internodes, or dissepiments and articulations. In the latter, the cells of the minor filaments are of unequal length, so that no articulations are obvious in the compound body. In *Polysiphonia* and *Rhodomela* may be seen examples of such articulate and inarticulate filaments.

By Kützing the term *phycoma* is applied to such compound stems; and when the phycoma becomes flattened or leaf-like, a new term, *phylloma*, is given to it by the same author. These terms are sometimes convenient in describing particular structures, though not yet generally adopted. The cells of which compound stems (or *phycomata*), are composed are very variously arranged, and on this cellular arrangement, or internal structure of the stem, depends frequently the place in the system to which the plant is to be referred. A close examination, therefore, of the interior of the frond, by means of thin slices under high powers of the microscope, is often necessary, before we can ascertain the position of an individual plant whose relations we wish to learn. Sometimes all the cells have a longitudinal direction, their longer axes being vertical. Very frequently, this longitudinal arrangement is found only toward the centre of the stem, while toward the circumference the cells stand at right angles to those of the centre, or have a horizontal direction. In such stems we distinguish a proper *axis*, running through the frond, and a *periphery*, or *peripheric stratum*, forming the outside layer or circumference. Sometimes the axis is the densest portion of the frond, the filaments of which it is composed being very strongly and closely glued together; in other cases it is very lax, each individual filament lying apart from its fellow, the interspaces being filled up with vegetable mucus or gelatine. This gelatine differs greatly in consistence; in some Algæ it is very thin and watery, in others it is

slimy, and in others it has nearly the firmness of cartilage. On the degree of its compactness and abundance depends the relative *substance* of the plant; which is membranaceous where the gelatine is in small quantity; gelatinous where it is very abundant and somewhat fluid; or cartilaginous where it is firm.

The frond may be either cylindrical or stem-like, or more or less compressed and flattened. Often a cylindrical stem bears branches which widen upwards, and terminate in leaf-like expansions, which are of various degrees of perfection in different kinds. Thus sometimes the leaf, or *phylloma*, is a mere dilatation; in other cases it is traversed by a midrib, and in the most perfect kinds lateral nervelets issue from the midrib and extend to the margin. These leaves are either vertical, which is their normal condition, or else they are inclined at various angles to the stem or axis, chiefly from a twisting in their lamina, the insertion of the leaf preserving its vertical position. They are variously lobed or cloven, and in a few cases (as in the *Sea Colander* of the American coast) they are regularly pierced, at all ages, with a series of holes which seem to originate in some portions of the lamina developing new cells with greater rapidity than other parts, thus causing an unequal tension in various parts of the frond, and consequently the production of holes in those places where the growth is defective. Such plants, though they form lace-like fronds, are scarcely to be considered as net works. Net-like fronds are, however, formed by several Algæ where the branches regularly anastomose one with another, and form meshes like those of a net. Most species with this structure are peculiar to the Southern Ocean, but in the waters of the Caribbean Sea are found two or three which may perhaps yet be detected on the shores of the Florida Keys. In one of the Australian genera of this structure (*Claudea*) the net-work is formed by the continual anastomosis of minute leaflets, each of which is furnished with a midrib and lamina. The apices of the midribs of one series of these leaves grow into the dorsal portion of leaves that issue at right angles to them, and as the leaves having longitudinal and horizontal directions, or those that form the warp and weft of the frond, are of minute size and closely and regularly disposed, the net-work that results is lace-like and delicately beautiful.

In the *Hydrodictyon*, a fresh water Alga, found in ponds in Europe and in the United States, where it was first detected by Professor Bailey near Westpoint, a net-like frond is formed in a different manner. This plant when fully grown resembles an ordinary fishing-net of fairy size, each pentagonal mesh being formed of five cells, and one cell making a side of the pentagon. As the plant grows larger, the meshes become wider by the lengthening of the cells of which each mesh is composed. When at maturity, the matter contained within each cell of the mesh is gradually organised into granules, or germs of future cells, and these become connected together in fives while yet contained in the parent cell. Thus meshes first, and at length little microscopic networks, are formed within each cell of the meshes of the old net; and this takes place before the old net breaks up. At length the cells of the old net burst, and from each issues forth the little network, perfectly formed, but of very minute size, which by an expansion of its several parts will become a net like that

from which its parent cell was derived. Thus, supposing each cell of a single net of the Hydrodictyon were to be equally fertile, some myriads of new nets would be produced from every single net, as it broke up and dissolved. In this way a large surface of water might be filled with the plant in a single generation.

The manner of growth of the frond is very various in the different families. In some, the body lengthens by continual additions to its apex, every branch being younger the further removed it is from the base; that is, the tips of the branches are the youngest parts. This is the usual mode of growth in the Confervoid genera, and also obtains in many of those higher in the series, as in the Fucaceæ and many other Melanosperms. In the Laminariæ, on the contrary, the apex when once formed does not materially lengthen, but the new growth takes place at the base of the lamina, or in the part where the cylindrical stipe passes into the expanded or leaflike portion of the frond. In such plants the apex is rarely found entire in old specimens, but is either torn by the action of the waves, or thrown off altogether, and its place supplied by a new growth from below. In several species this throwing off of the old frond takes place regularly at the close of each season; the old lamina being gradually pushed off by a young lamina growing under it. There are others, among the filiform kinds, in which the smaller branches are suddenly deciduous, falling off from the larger and permanent portions of the trunk, as leaves do in autumn from deciduous trees. Hence specimens of these plants collected in winter are so unlike the summer state of the species, that to a person unacquainted with their habits they would appear to be altogether different in kind. The summer and winter states of *Rhodomela subfusca* are thus different. In *Desmarestia aculeata* the young plants, or the younger branches of old plants, are clothed with soft pencils of delicate jointed filaments, which fall off when the frond attains maturity, and leave naked, thorny branches behind. Similar delicate hairs are found in many other Algæ of very different families, generally clothing the younger and growing parts of the frond; and they seem to be essential organs, probably engaged in elaborating the crude sap of these plants, and consequently analogous to the leaves of perfect plants. This is as yet chiefly conjectural. The conjecture, however, is founded on the observed position of these hair-like bodies, which are always found on growing points, the new growth taking place immediately beneath their insertion. In most cases these hairs are deciduous, but in some, as in the genus *Dasya*, they are persistent, clothing all parts of the frond so long as they continue in vigour. They vary much in form, in some being long, filiform, single cells; in others, unbranched strings of shorter cells, and in others dichotomous, or, rarely, pinnated filaments.

Three principal varieties of

COLOUR

are generally noticed among the Algæ, namely, *Grass-green* or *Herbaceous*, *Olive-green*, and *Red*; and as these classes of colour are pretty constant among otherwise allied species, they afford a ready character by which, at a glance, these plants may be separated into natural divisions; and hence *colour* is here employed in classifi-

cation with more success than among any other vegetables. In the subdivision of Algæ into the three groups of *Chlorosperms*, *Melanosperms*, and *Rhodosperms*, the colour of the frond is, as we shall afterwards see, employed as a convenient diagnostic character. It is a character, however, which must be cautiously applied in practice by the student, because, though sufficiently constant on the whole and under ordinary circumstances, exceptions occur now and then ; and under special circumstances Algæ of one series assume in some degree the colour of either of the other series.

The *green* colour is characteristic of those that grow either in fresh water or in the shallower parts of the sea, where they are exposed to full sunshine but seldom quite uncovered by water. Almost all the fresh water species are green, and perhaps three fourths of those that grow in sunlit parts of the sea ; but some of those of deep water are of as vivid a green as any found near the surface, so that we cannot assert that the *green* colour is owing here, as it is among land plants, to a perfect exposure to sunlight. Several species of *Caulerpa*, *Anadyomene*, *Codium*, *Bryopsis* and others of the Siphonæ, which are not less herbaceous or vivid in their green colours than other Chlorosperms, frequently occur at considerable depths, to which the light must be very imperfectly transmitted.

Algæ of an *olivaceous* colour are most abundant between tide marks, in places where they are exposed to the air, at the recess of the tide, and thus alternately subjected to be left to parch in the sun, and to be flooded by the cool waves of the returning tide. They extend however to low water mark, and form a broad belt of vegetation about that level, and a few straggle into deeper water, sometimes into very deep water. The gigantic deep-water Algæ, *Macrocystis*, *Nereocystis*, *Lessonia*, and *Durvillæa*, are olive coloured.

Red-coloured Algæ are most abundant in the deeper and darker parts of the sea, rarely growing in tide pools, except where they are shaded from the direct beams of the sun either by a projecting rock, or by over-lying olivaceous Algæ. The red colour is always purest and most intense when the plant grows in deep water, as may be seen by tracing any particular species from the greatest to the least depth at which it is found. Thus, the common *Ceramium rubrum* in deep pools or near low-water mark is of a deep, full red, its cells abundantly filled with bright carmine endochrome, which will be discharged in fresh water so as to form a rose-coloured infusion ; but the same plant, growing in open, shallow pools, near high water mark, where it is exposed to the sun, becomes very pale, the colour fading through all shades of pink down to dull orange or straw-colour. It is observable that this plant, which is properly one of the *red* series (or *Rhodosperms*) does not become grass-green (or like a *Chlorosperm*) by being developed in the shallower water, but merely loses its capacity for forming the red-coloured matter peculiar to itself. So also, *Laurencia pinnatifida*, and other species of that genus, which are normally dark purple, are so only when they grow near low water mark. And as many of them extend into shallower parts, and some even nearly to high water limit, we find specimens of these plants of every shade of colour from dull purple to dilute yellow or dirty white. Similar changes of colour, and from a similar cause, are seen in *Chondrus crispus*, the *Carrigeen* or *Irish Moss*, which is properly of a fine deep

purplish red, but becomes greenish or whitish when growing in shallow pools. The *white* colour, therefore, which is preferred in carrigeen by the purchaser of the prepared article, is entirely due to bleaching and repeated rinsing in fresh water.

Many Algæ, both of the *olive* and *red* series, and in a less perfect manner a few of the *grass-green* also, reflect prismatic colours when growing under water. In some species of *Cystoseira*, particularly in the European *C. ericoides* and its allies, these colours are so vivid that the dull olive-brown branches appear, as they wave to and fro in the water, to be clothed with the richest metallic greens and blues, changing with every movement, as the beams of light fall in new directions on them. Similar colours, but in a less degree, are seen on *Chondrus crispus* when growing in deep water; but here the prismatic colouring is often confined to the mere tips of the branches, which glitter like sapphires or emeralds among the dark purple leaves. The cause of these changeable colours has not been particularly sought after. The surface may be finely striated, but it does not seem to be more so than in other allied species, where no such iridescence has been observed. In the *Chondrus* the changeable tints appear to characterize those specimens only which grow in deep water, and which are stronger and more cartilaginous than those which grow in shallow pools.

Fresh water has generally a very strong action on the colours as well as on the substance of marine Algæ which are plunged into it. To many it is a strong poison, rapidly dissolving the gelatine which connects the cells, and dissolving also the walls of the cells themselves; and that so quickly that in a few minutes one of these delicate plants will be dissolved into a shapeless mass of broken cells and slime. Many species which, when fresh from the sea, resist the action of fresh water, and may be steeped in it without injury for several hours, if again moistened after having once been dried, will almost instantly dissolve and decompose. This is remarkably the case with several species of *Gigartina* and *Iridæa*. The first effect of fresh water on the red colours of Algæ is to render them brighter and more clear. Thus *Dasya coccinea*, *Gelidium cartilagineum*, *Plocamium coccineum*, and others, are when recent of a very dark and somewhat dull red colour; but when exposed either to showers and sunshine on the beach, or to fresh water baths in the studio of the botanist, become of various tints of crimson or scarlet, according as the process is continued for a less or greater length of time. At length the colouring matter would be expelled and the fronds bleached white, as occurs among the specimens cast up and exposed to the long continued action of the air; but if stopped in time and duly regulated, the colours may be greatly heightened by fresh water. Some plants which are dull brown when going into the press, come out a fine crimson; this is the case with *Delesseria sanguinea*, though that plant is not always of a dull colour when recent. Others, which are of the most delicate rosy hues when recent, become brown or even black when dried. This is especially the case in the order *Rhodomelaceæ*, so named from this tendency of their reds to change to black in drying. The tendency to become black, though it cannot be altogether overcome in these plants, may often be lessened by steeping them in fresh water for some time previous to drying. Hot water generally changes the colours of all Algæ to green, and if heat be applied during the drying process, an

artificial green may be imparted to the specimens ; but such a mode of preparation of specimens ought never to be practised by botanical collectors, though it may sometimes serve the purpose of makers of seaweed pictures.

THE FRUCTIFICATION

of the Algæ may be more conveniently described in the systematic portion of this work, when speaking of the various forms it assumes in the different families. I shall at present, therefore, limit myself to a very few general observations. The *spore* or reproductive gemmule of the Algæ is in all cases a simple cell, filled with denser and darker coloured endochrome (or colouring matter) than that found in other cells of the frond. In the simplest Algæ, where the whole body consists of a single cell, some gradually change and are converted into spores, without any obvious contact with others: but far more frequently, as in the *Desmidiaceæ* and *Diatomaceæ*, a spore is formed only by the conjugation of two cells or individual plants. When these simple vegetable atoms are mature, and about to form their fructification, two individuals are observed to approach ; a portion of the cell-wall of each is then extended into a tubercle at opposite points; these tubercles come into contact and at length become confluent ; the dissepiment between them vanishes, and a tube is thus formed connecting the two cavities together. Through this tube the matter contained in both the old cells is transmitted and becomes mixed ; changes take place in its organization, and at length a *sporangium* or new cell filled with spores is formed from it, either in one of the old cells, or commonly at the point of the connecting tube, where the two are soldered together. Then the old empty cells or plants die, and the species is represented by its *sporangium*, which may remain dormant, retaining vitality for a considerable time, as from one year to another, or probably for several years. These sporangia, which are abundantly formed at the close of the season of active growth, become buried in the mud at the bottoms of pools, where they are encased on the drying up of the water in summer, and are ready to develop into new fronds on the return of moisture in spring.

Many of the lower Algæ form fruit in this manner, to which the name *conjugation* is technically given. The thread-like Silk-weeds of ponds and ditches (*Zygnemata* and *Mougeotia*, &c.) are good examples of such a mode of fruiting. In these almost every cell is fertile, and when two threads are yoked together, a series of *sporangia* will be formed in one thread, while the other will be converted into a string of dead, empty cells. Before conjugation there was, seemingly, no difference between the contents of one set of cells and of the other ; so that there is no clear proof of the existence of distinct sexes in these plants, however much the process of fruiting observed among them may indicate an approach to it.

The process of fruiting in the higher Algæ appears to be very similar: namely, *spores* or *sporangia* appear to be formed by certain cells attracting to themselves the contents of adjacent cells ; and in the compound kinds empty cells are almost always found in the neighbourhood of the fruit cells ; but with the complication of the parts of the frond, the exact mode in which spores are formed becomes more diffi-

cult of observation. At length, among the highest Algæ we encounter what appear to be really two sexes, one analogous to the anther and the other to the pistil of flowering plants. It would seem, however, that it is not each individual spore which is fertilized, as is the case in seed-bearing plants; but that the fertilizing influence is imparted to the pistil or sporangium itself, when that body is in its most elementary form, long before any spore is produced in its substance, and even when it is itself scarcely to be distinguished from an ordinary cell. *Antheridia*, as the supposed fertilizing organs are called, are most readily seen among the *Fucaceæ*, and will be described under that family.

Besides the reproduction by means of proper spores, many Algæ have a second mode of continuing the species, and some even a third. Among the simpler kinds, where the whole body consists of a single cell, a fissiparous division, exactly similar to the fissiparous multiplication of cells among higher plants, takes place. This cell, as has been already mentioned, divides at maturity into two parts, which, falling asunder, become separate individuals. Similar self-division has been noticed among the lower *Palmellaceæ*, and in other imperfectly organized families. Such a mode of multiplying individuals is analogous to the propagation of larger plants by the process of gemmation, where buds are formed and thrown off to become new individuals. When, as in the *Lemna* or *Duckweed*, the whole vegetable body is as simple as a phanerogamous plant can well be, the new frondlets or buds are produced in a manner very strikingly analogous to the production of new fronds in *Desmidiaceæ*.

The third mode of continuing the species has been observed in many Algæ of the *green* series, in some of which sporangia are also formed, but in others no fructification other than what I am about to describe has been detected. This mode is as follows. In an early stage, the green matter, or *endochrome*, contained within the cells of these Algæ, is of a nearly homogeneous consistence throughout, and semi-fluid; but at an advanced period it becomes more and more granulated. The granules when formed in the cells at first adhere to the inner surface of the membranous wall, but soon detach themselves and float freely in the cell. At first they are of irregular shapes, but they gradually become spheroidal. They then congregate into a dense mass in the centre of the cell, and a movement aptly compared to that of the swarming of bees round their queen begins to take place. One by one these active granules detach themselves from the swarm, and move about in the vacant space of the cell with great vivacity. Continually pushing against the sides of the cell wall, they at length pierce it, and issue from their prison into the surrounding fluid, where their seemingly spontaneous movements are continued for some time. These vivacious granules, or *zoospores* as they have been called, at length become fixed to some submerged object, where they soon begin to develop cells, and at length grow into Algæ similar to those from whose cells they issued.

Their spontaneous movements before and immediately subsequent to emission lead me to speak of the

MOVEMENTS OF ALGÆ

in general. These are of various kinds, and of greater or less degrees of vivacity

In some Algæ a movement from place to place continues through the life of the individual, while in others, as in the zoospores of which I have just spoken, it is confined to a short period, often to a few hours, in the transition state of the spore, after it escapes from the parent filament and until it fixes itself and germinates. Many observers have recorded these observations, which are to be found detailed in various periodicals.* I shall here notice only a few cases illustrative of the various kinds of movement. The most ordinary of these movements is effected by means of vibratile *cilia* or hairs, produced by the membrane of the spore, and which by rapid backward and forward motion, like that of so many microscopic oars, propel the body through the water in different directions, according as the movement is most directed to one side or the other. Sometimes the little spores, under the influence of these cilia, are seen to spin round and round in widening circles; but at other times change of direction, pauses, accelerations, &c. take place during the voyage, which look almost like *voluntary* alterations, or as if the spore were guided by a principle of the nature of animal will. Hence many observers do not hesitate to call these moving spores *animalcules*, and to consider them of the same nature as the simpler infusorial animals.

This, as it appears to me, is a conclusion which ought not to be hastily assumed, not merely taking into consideration the extremely minute size of the little bodies to be examined, and the consequent danger of our being deceived as to the cause of movement, and of its interruption and resumption, but also remembering the facts ascertained by Mr. Brown, of the movement of small particles of all mineral substances which he examined. Many of the spores in question are sufficiently small to come under the Brownian law, though others are of larger size. Besides, if we regard the moving spores as animalcules, we must either adopt the paradox that a vegetable produces an animal, which is then changed into a vegetable, and the process repeated through successive generations, every one of these *vegetables* having been *animal* in its infancy; or else, notwithstanding their strongly marked vegetable characteristics, we must remove to the animal kingdom all Algæ with moving spores.

Neither of these violent measures is necessary, if we admit that mere motion, apart from other characters, is no *proof* of animality. Though motion under the control of a will be indeed one of the charter privileges of the higher animals, we see it gradually reduced as we descend in the animal scale, until at last it is nearly lost altogether. Long before we reach the lowest circles in the animal world, we meet with animals which are fixed through the greater part of their lives to the rocks on which they grow, and some of them have scarcely any obvious movement on their point of attachment. In some the surface, like that of the Algæ-spores, is clothed with cilia which drive floating particles of food within reach of the mouth; in others even these rudimentary prehensile organs are dispensed with, and the animal exists as a scarcely irritable flesh expanded on a framework. This would seem to be the case in the corals of the genus *Fungia*, if the accounts given of those animals be correct; while in the sponges the animal structure and organization are still further reduced, so as almost to contravene our preconceived notions of animal-will and

* See *Annales des Sciences Naturelles*; *Taylor's Ann. Nat. Hist.*; the *Linnæa*, &c. various volumes.

movement. But the sponges can scarcely be far removed from Fungia, nor can that be separated from other corals : so that, though I am aware some naturalists of eminence regard the sponges as vegetables, I cannot subscribe to that opinion, but rather view them as exhibiting to us animal organization in its lowest conceivable type, and parallel to vegetable organization, as that exists in the lowest members of the class of Algæ.

This hasty glance at the animal kingdom teaches us that voluntary motion is a character variable in degree, and at length reduced almost to zero within the animal circle. On the other hand, we know that movements of a very extraordinary character exist among the higher vegetables. Not merely the movement of the fluids of plants within their cells, which has at least some analogy with the motion of animal fluids ; but in such plants as the Sensitive-plant, the Venus's Flytrap (*Dionæa*), and many others, movements of the *limbs* (shall I call them ?) as singular as those of the Algæ-spores, are sufficiently well known. And these movements are affected by narcotics in a manner strikingly similar to the operation of similar agents on the nervous system of animals. The common sensitive-plant, indeed, only shrinks from the touch, but in the *Desmodium gyrans* a movement of the leaves on their petioles is habitually kept up, as if the plant were fanning itself continually. Such vegetable movements as these strike us by their rapidity, but others of a like nature only escape us by their slowness. Thus the opening of the leaves of many plants in sunlight and their closing regularly in the evening in sleep ; the constant turning of the growing points towards the strongest light, and other changes in position of various organs, are all vegetable movements which would appear as *voluntary* as those of the Algæ spores if they were equally rapid. Their extreme slowness alone conceals their true nature.

So then we find animals in which *motion* is reduced almost to a nullity ; and vegetables as high in the scale as the *Leguminosæ* exhibiting well marked movements, facts which sufficiently establish the truth of our position that *mere motion* is no proof of animality. But subtracting their movements from the Algæ-spores, what other proof remains of their being animalcules ? None whatever. They do not resemble animalcules either in their internal structure, their chemical composition, or their manner of feeding ; and their vegetable nature is sufficiently marked by their decomposing carbonic acid, giving out oxygen in sunlight, and containing starch.

In the *Vaucheria clavata*, one of the species in which spores moved by cilia were first observed, the spore is formed at the apices of the branches. The frond in this plant is a cylindrical, branching cell, filled with a dense, green endochrome. A portion of the contained endochrome immediately at the tips separates from that which fills the remainder of the branch ; a dissepiment is formed, and that portion cut off from the rest gradually consolidates into a spore, while the membranous tube enlarges to admit of its growth. The young spore soon becomes elliptical, and at length, being clothed with a skin and ready for emission, it escapes through an opening then formed at the summit of the branch. The whole surface of the spore, when emitted, is seen to be clothed with vibratile cilia whose vibrations propel it through the water until it reaches a place suitable for germination.

The cilia then disappear, and the spore becoming quiescent, at length developes into a branching cell like its parent. The history of other moving spores is very similar, the cilia, however, varying much in number in different species; commonly they are only two, which are sometimes inserted as a pair, at one end of the spore, but in other cases placed one at each end.

There are other Algæ in which vibratile cilia have not been observed, but which yet have very agile movements. Among these the most remarkable are the *Oscillatorie* and their allies, which suddenly appear and disappear in the waters of lakes and ponds, and sometimes rise to the surface in such prodigious numbers as to colour it for many square miles. In *Oscillatoria* each individual is a slender, rigid, needle-shaped thread, formed of a single cell, filled with a dense endochrome which is annulated at short intervals, and which eventually separates into lenticular spores. Myriads of such threads congregate in masses, connected together by slimy matter, in which they lie, and from the borders of which, as it floats like a scum on the water, they radiate. Each thread, loosely fixed at one end in the slimy matrix, moves slowly from side to side, describing short arcs in the water, with a motion resembling that of a pendulum; and, gradually becoming detached from the matrix, it is propelled forward. These threads are continually emitted by the stratum, and diffused in the water, thus rapidly colouring large surfaces. When a small portion of the matrix is placed over-night in a vessel of water, it will frequently be found in the morning that filaments emitted from the mass have formed a pellicle over the whole surface of the water, and that the outer ones have pushed themselves up the sides, as far as the moisture reaches.

The *Oscillatorie*, though most common in fresh water, are not peculiar to it. Some are found in the sea, and others in boiling springs, impregnated with mineral substances. It has been ascertained that the red colour which gives name to the Arabian Gulf is due to the presence of a microscopic Alga (*Trichodesmium erythraeum*), allied to *Oscillatoria*, and endowed with similar motive powers, which occasionally permeates the surface-strata of the water in such multitudes as completely to redden the sea for many miles. The same or a similar species has been noticed in the Pacific Ocean in various places, by almost every circumnavigator since the time of Cook, who tells us his sailors gave the little plant the name of "sea sawdust." Mr. Darwin compares it to minute fragments of chopped hay, each fragment consisting of a bundle of threads adhering together by their sides.

These minute plants move freely through the water, rising or sinking at intervals, and when closely examined they exhibit motions very similar to those of *Oscillatorie*. There are several of such quasi-animal-plants now known to botanists, and almost all belong to the *green* series of the Algæ, which are placed in our system at the extreme base of the vegetable scale of being.

HABITAT.

The *habitat* or place of growth of the Algæ is extremely various. Wherever moisture of any kind lies long exposed to the air, Algæ of one group or other are found in it. I have already alluded to the *Hygrocrocis*, so troublesome in vats of

sulphate of copper, and many, perhaps almost all other chemical solutions, become filled in time, and under favorable circumstances, with a similar vegetation. The waters of mineral springs, both hot and cold, have species peculiar to them. Some, like the Red snow plant, diffuse life through the otherwise barren snows of high mountain peaks and of the polar regions; and on the surface of the polar ice an unfrozen vegetation of minute Algæ finds an appropriate soil. There are species thus fitted to endure all observed varieties of temperature. Moisture and air are the only essentials to the development of Algæ. It has even been supposed that the minute *Diatomaceæ* whose bodies float through the higher regions of the atmosphere, and fall as an impalpable dust on the rigging of ships far out at sea, have been actually developed in the air; fed on the moisture semicondensed in clouds; and carried about with these "lonely" wanderers.

When this atmospheric dust was first noticed, naturalists conjectured that the fragments of minute Algæ of which the microscope showed it to be composed, had been carried up by ascending currents of air either from the surface of pools, or from the dried bottoms of what had been shallow lakes. But a different origin has recently been attributed to this precipitate of the atmosphere by Dr. F. Cohn, Professor Ehrenberg, and others, who now regard it as evidence of the existence of organic life in the air itself! This opinion is founded on the alleged fact, that atmospheric dust, collected in all latitudes, from the equator to the circumpolar regions, consists of remains of the same species, and that certain characteristic forms are always found in it, and are rarely seen in any other place. Hence it is inferred that the dust has a common origin, and its universal diffusion round the earth points to the air itself as the proper abode of this singular fauna and flora,—for minute animals would seem to accompany and doubtless to feed upon the vegetable atoms. If this be correct, and not an erroneous inference from a misunderstood phenomenon, it is one of the most extraordinary facts connected with the distribution and maintenance of organic life.

If Algæ thus people the finely divided vapour that floats above our heads, we shall be prepared to find them in all water condensed on the earth. The species found on damp ground are numerous. These are usually of the families *Palmellaceæ* and *Nostochaceæ*. To the latter belong the masses of semi-transparent green jelly so often seen among fallen leaves on damp garden walks, after continued rains in autumn and early winter. These jellies are popularly believed to fall from the atmosphere, and by our forefathers were called *fallen stars*.* If such be their origin, we are tempted to address them, with Cornwall in King Lear,

"Out vile jelly! where is thy lustre now?"

for certainly nothing can well be less star-like than a Nostoc, as it lies on the ground.

An appeal to the microscope reveals beauty indeed in this humble plant, but gives no countenance to the popular belief of its meteoric descent. It is closely related in structure to other species found under dripping rocks and in lakes and ponds,

* Other substances besides Nostocs occasionally get this name. Masses of undeveloped frog-spawn, for instance, dropped by buzzards and herons, pass for meteoric deposits.

and the only reason for regarding it as an aerial visitant is the suddenness of its appearance after rain.

In certain moist states of the atmosphere, accompanied by a warm temperature, the *Nostoc* grows very rapidly; but what seems a *sudden* production of the plant has possibly been long in preparation unobserved. When the air is dry the growth is intermitted, and the plant shrivels up to a thin skin, but on the return of moisture this skin expands, becomes gelatinous, and continues its active life. And as this process is repeated from time to time, it may be that the large jelly which is found after a few days rain is of no very recent growth. A friend of mine who happened to land in a warm dry day on the coast of Australia, and immediately ascended a hill for the purpose of obtaining a view of the country, was overtaken by heavy rains; and was much surprised to find that the whole face of the hill quickly became covered with a gelatinous Alga, of which no traces had been seen on his ascent. In descending the hill in the afternoon, on his return to the ship, he was obliged to slide down through the slimy coating of jelly, where it was impossible to proceed in any other way. No doubt, in this case, a species of *Nostoc* which had been unnoticed when shrivelled up had merely expanded with the morning's rain.

Where water lies long on the surface of the ground, as happens in cases of floods, it quickly becomes filled with *Confervæ* or *Silk-weeds*, which rise to the surface in vast green strata. These simple plants grow with great rapidity, using up the materials of the decaying vegetation which is rotting under the inundation, and thus they in great measure counteract the ill effects to the atmosphere of such decay. When the water evaporates, their filaments, which consist of delicate membranous cells, shrivel up and become dry, and the stratum of threads, now no longer green, but bleached into a dull white, forms a coarsely interwoven film of varying thickness, spread like great sheets of paper over the decaying herbage. This *natural paper*, which has also been described under the name of *water flannel*, sometimes covers immense tracts, limited only by the extent of the flood in whose waters it originated.

But though Algæ abound in all reservoirs of fresh water, the waters of the sea are their peculiar home; whence the common name "Seaweeds," by which the whole class is frequently designated. Very few other plants vegetate in the sea, seawater being fatal to the life of most seeds; yet some notable exceptions to this law (in the case of the cocoa nut, mangrove, and a few other plants) serve a useful purpose in the economy of nature.

The sea in all explored latitudes has a vegetation of Algæ. Towards the poles, this is restricted to microscopic kinds, but almost as soon as the coast rock ceases to be coated with ice, it begins to be clothed with *Fuci*: and this without reference to the mineral constituents of the rock, the *Fucus* requiring merely a resting place. Seaweeds rarely grow on sand, unless when it is very compact and firm. There are, therefore, submerged sandy deserts, as barren as the most cheerless of the African wastes. And when such barrens interpose, along a considerable extent of coast, between one rocky shore and another, they oppose a strong barrier to the dispersion of species, though certainly not so strong as the aerial deserts; because

the waters which flow over submarine sands will carry the spores of the Algæ with less injury than the winds of the desert will convey the seeds of plants from one oasis to another. It cannot, however, be doubted that submerged sands do exercise a very material influence on the dispersion of Algæ, or their

GEOGRAPHICAL DISTRIBUTION.

Climate has an effect on the Algæ as upon all other organic bodies, though its influence is less perceptible in them than in terrestrial plants, because the temperature of the sea is much less variable than that of the air. Still, as the temperature of the ocean varies with the latitude, we find in the marine vegetation a corresponding change, certain groups, as the *Laminariæ*, being confined to the colder regions of the sea; and others, as the *Sargassa*, only vegetating where the mean temperature is considerable.

These differences of temperature and corresponding changes of marine vegetation, which are mainly dependent on actual distance from the equatorial regions, are considerably varied by the action of the great currents which traverse the ocean, carrying the waters of the polar zone toward the equator, and again conveying those of the torrid zone into the higher latitudes. Thus, under the influence of the warm waters of the Gulf Stream, Sargassum is found along the east coast of America as far as Long Island Sound (Lat. 44°). And again, the cold south-polar current which strikes on the western shores of South America, and runs along the coasts of Chili and Peru, has a marked influence on the marine vegetation of that coast, where *Lessonia*, *Macrocystis*, *Durvillæa*, and *Iridæa*, characteristic forms of the marine flora of Antarctic lands, approach the equator more nearly than in any other part of the world.

The influence of currents of warmer water is also observable in the submarine flora of the west coast of Ireland, where we find many Algæ abounding in lat. 53°, which elsewhere in the British Islands are found only in the extreme south points of Devon and Cornwall. These, and other instances which might be given, are sufficient to show that average temperature has a marked influence in determining the marine vegetation of any particular coast.

Seasons of greater cold or heat than ordinary have, as might be inferred, a corresponding action. This is particularly noticeable among the smaller and more delicate kinds which grow within tide marks, and are found in greater luxuriance or in more abundant fruit in a warm than in a cold season. And the difference becomes more strongly marked when the particular species is growing near the northern limit of its vegetation. Thus in warm summers, *Padina Pavonia* attains, on the south coast of England, a size as large as it does in sub-tropical latitudes; while in a cold season it is dwarf and stunted.

In speaking of the difference in colour of Algæ, I have already noticed the prevalence of particular colours at different depths of water. A corresponding change of specific form takes place from high to low water mark; and as the depth increases, the change is strikingly analogous to what occurs among land plants at different elevations above the sea. Depth in the one case has a correspondent

effect to height in the other ; and the Algæ of deep parts of the sea are to those of tidal rocks, as alpine plants are to littoral ones. In both cases there is a limit to the growth of species ; each ærial species having a line above which it does not vegetate, and each marine one, a line beyond which it does not descend. And as, at last, we find none but the least perfect lichens clothing the rocks of high mountains, so in the sea beyond a moderate depth are found no Algæ of higher organization than the *Diatomaceæ*.

These latter atomic plants would appear to exist in countless numbers at very extraordinary depths, having been constantly brought up by the lead in the deep sea soundings recorded in Sir James Ross's Antarctic voyage. But ordinary sea plants cease to vegetate in comparatively shallow water, long before animal life ceases. The limits have not been accurately ascertained, and are probably much exaggerated as commonly given in books.

Lamouroux speaks of ordinary Algæ growing at 100 to 200 fathoms, but we have no exact evidence of the existence of these plants at this great depth. The *Macrocystis*, the largest Alga known, has sometimes been seen vegetating in 40 fathoms (*Hook. Fl. Ant. vol. 2, p. 464*) water, while its stems not merely reached the surface, but rose at an angle of 45° from the bottom, and streamed along the waves for a distance certainly equal to several times the length of the "Erebus ;" data which, if correct, give the total length of stem at about 700 feet. Dr. Hooker, however, considers this an exceptional case, and gives from eight to ten fathoms as the utmost depth at which submerged seaweed vegetates in the southern temperate and Antarctic ocean ; a depth which is probably much exceeded in the tropics, and which is at least equalled by Algæ of the north temperate zone.

Humboldt, in his "Personal Narrative" mentions having dredged a plant to which he gave the name *Fucus vitifolius*, (probably a *Codium* or *Flabellaria*) in water 32 fathoms deep, and remarks that, notwithstanding the weakening of the light at that depth, the colour was of as vivid a green as in Algæ growing near the surface. I possess a specimen of *Anadyomene stellata* dredged at the depth of 20 fathoms, in the Gulph of Mexico, by my venerable friend the late Mr. Archibald Menzies, and it is as green as specimens of the same plant collected by me between tide marks at Key West, and is much more luxuriant.

Professor Edward Forbes, whose admirable report on the Ægean Sea should be consulted by all persons interested in the distribution of life at various depths, dredged *Constantinea reniformis*, Post. and Rupr. in 50 fathoms, the greatest depth perhaps on record, as accurately observed, at which ordinary Algæ vegetate. I say, ordinary Algæ, for it will be remembered that Diatomaceæ exist in the profound abysses of the ocean, as far as we are acquainted with them.

And besides these microscopic vegetables, Algæ of a group called *Nullipores* or *Corallines* (*Corollinaceæ*), long confounded with the Zoophytes, become more numerous as other Algæ diminish, until they characterize a zone of depth where they form the whole obvious vegetation. These remarkable plants assimilate the muriate of lime of seawater and form a carbonate in their tissues, which from the great abundance of this deposit become stony. The less perfect Nullipores are scarcely distinguishable, by the naked eye, from any ordinary calcareous incrus-

tation, and strongly resemble the efflorescent forms, like cauliflowers, seen so frequently in the sparry concretions of limestone caverns. Others, more perfect, become branched like corals; and the most organised of the group, or the true corallines, have symmetrical, articulated fronds. This stony vegetation affords suitable food to hosts of zoophytes and mollusca, which require lime for the construction of their skeletons or shells, and it probably extends to a depth as great as such animals inhabit.

When the same species is found at different depths, there is generally a marked difference between the specimens. Thus, when an individual plant grows either in shallower or in deeper water than that natural to the species, it becomes stunted or otherwise distorted. I have noticed in many species (as in *Plocamium coccineum*, *Dasya coccinea*, *Laurencia dasyphylla*, various *Hypnæ*, and many others) that the specimens from deep water have divaricated branches and ramuli, and a tendency to form both hooks and discs or supplementary roots, from various points of the stem and branches. Sometimes the outward habit is so completely changed by the production of hooked processes and discs, that it is difficult to discover the affinity of these distorted forms; and such specimens have occasionally been unduly elevated to the rank of species.

When water of great depth intervenes, on a coast between two shallower parts of the sea, it frequently limits the distribution of species, acting as a high mountain range would in the distribution of land plants; but in a far less degree; as it is obviously easier for the spores of the Algæ to be floated across the deep gulf, than for the seeds of land plants to pass the snowy peaks of a mountain.

The intervention of sand, already alluded to, is a far greater barrier, because sandy tracts are usually of much greater extent than submarine obstacles of any other kind. To the prevalence of a sandy coast, in a great measure probably, is owing the very limited distribution of the *Fucaceæ* on the eastern shores of North America, where plants of this family are scarcely found from New York to Florida. Since the erection of a breakwater at Sullivan's Island, S. C., many Algæ not before known in those waters have, according to Professor L. R. Gibbes's authority, made their appearance, but none of the *Fucaceæ* are yet among them. In due time *Sargassum vulgare* will probably arrive from the south.

Some attempt has been made to divide the marine flora into separate regions, the particulars of which I have detailed elsewhere.* In the descriptive portion of this work I shall notice the distribution of the several families, where it offers any marked peculiarity, and I shall at present confine myself to some remarks on the distribution of Algæ along the eastern and southern shores of the United States; here recording the substance of some verbal observations which I made at the Meeting of the American Association, held in Charleston, in March, 1850.

EASTERN SHORES OF NORTH AMERICA.

In comparing the marine vegetation of the opposite shores of the northern Atlantic,

* *Manual of British Marine Algæ, Introd.*, p. xxxvi. et seq. ed. 2.

a great resemblance is observed between the ordinary seaweeds that clothe the rocks on the eastern and western sides ; with this difference, that the species do not reach so high a latitude on the American shore as on the European. The reason of this will be readily understood by inspecting a physical map of the Atlantic, on which Humboldt's Isothermal lines, or lines of mean annual temperature, are laid down. For then it will at once be seen that there is a very considerable bending of the Isothermal lines in favour of the continent of Europe. Thus the same line that runs through New York, in lat. 41° , strikes the shores of Europe in the North of Ireland, lat. 54° . And though there is less difference in mean temperature in the southern parts of the continents than in the northern, still there is a marked difference throughout.

With respect to vegetation, *Laminaria longicruris* is common on the American shore—at least as far south as Cape Cod (lat. 42°) ; while on the European it has not been found south of Norway, save some stray, waterworn stems occasionally cast on the north of Ireland or Scotland.

Rhodymenia cristata, so very abundant in Boston harbour, ($42^{\circ} 30'$), where it enters largely into the composition of seaweed pictures, is rarely found in Europe south of Iceland and the northern parts of Norway ; its most southern limit being in the Frith of Forth, (56°), where it has been found but once or twice.

Delesseria hypoglossum has not been observed in America north of Charleston, (lat. 33°), while in Europe it occurs in Orkney, (lat. 59°), and is in great profusion and luxuriance on the north coast of Ireland in lat. 55° . The distribution of this species on the American shore is very anomalous if Charleston be its northern limit, for it certainly extends southward at least to Anastasia Island, (lat. $29^{\circ} 50'$). In the British seas it is most luxuriant on the Antrim shore, (55°), where its fronds are sometimes three feet in length ; southern specimens are generally much smaller, and in Devonshire it rarely measures more than three or four inches, which is the average size of specimens from the south of Europe, as well as of those found in Charleston harbour. If we are correct in limiting the American distribution of this species northward by Charleston, we have the remarkable fact that the greatest latitude attained by *Del. hypoglossum* in the north-western Atlantic is less by about 5° or 6° than the southern limit of the same species on the north-eastern, and by about 27° than the northern boundary of its distribution. This indicates a range which the isothermal lines can scarcely explain ; for the line which runs through Charleston strikes the coast of Spain. It is the more remarkable in this species, because the genus *Delesseria* is most numerous in the colder parts of the sea, its finest species being natives of Northern Europe and of Cape Horn and the Falkland Islands ; and, as we have seen, this very *D. hypoglossum* is no where of greater size or in greater plenty than in latitude 55° on the Irish coast.

It is different with *Padina Pavonia*, itself a tropical form, and belonging to a group peculiarly lovers of the sun. We are not surprised that in America this plant should not grow further north than the Keys of Florida, although, under some peculiarly favourable circumstances, it attains a limit 27° further north, on the south coast of England ; for in the land-vegetation of the two coasts there is something like an approach to similar circumstances, oranges and citrons being

occasionally ripened in the open air in Devonshire, and *Magnolia grandiflora* attaining an arborescent size. The remaining marine vegetation of the Florida Keys, as we shall presently see, has a greater resemblance to that of the Mediterranean than to that of the British coasts; and this is more in accordance with the land floras, in which palm trees are a feature in both countries.

Probably one half of the species of Algæ of the east coast of North America are identical with those of Europe—a very large portion when we contrast it with the strongly marked difference between the marine animals of the two shores; the testacea, and to a great extent even the fishes of the two continents, being dissimilar. The European species, on the same length of coast, are greatly the more numerous, which appears to be owing to the prevalence of sands, nearly destitute of Algæ, along so great a length of the American shore, and particularly along that portion which, from its latitude, ought to produce the greatest variety of Algæ, were the local circumstances favourable to their growth.

As Algæ are little indebted for nourishment to the soil on which they grow, merely requiring a secure resting place and a sheltered situation, their number generally bears a proportion to the amount of indented rocks that border the coast. Stratified rocks are more favourable to their growth than loose boulders or stones; but if the upper surface be smooth without cavities, it is either swept by the waves too rapidly to allow the growth of a vigorous vegetation; or, in quiet places, it becomes uniformly clothed with some of the Fuci, or other *social* species, which cover the exposed surface with a large number of individuals, to the destruction of more delicate species. The rocks, then, most adapted for Algæ are those in which, here and there, occur deep cavities affording shelter from the too boisterous waves. In these, on the recess of the tide, a *tide pool* or rock basin preserves the delicate fronds from the action of the sun. The rare occurrence of such situations on the American coast is doubtless a reason of the comparative poverty of the marine flora.

This comparative poverty is observable even in the common littoral Fuci or Rock Kelp. In Northern Europe, besides several rarer kinds, six species (namely *Fucus serratus*, *vesiculosus*, *nodosus*, *canaliculatus*; *Halidrys siliquosa*; and *Himanthalia lorea*) are extremely common, four of them at least being found on every coast. In America, *Fucus vesiculosus* and *nodosus* alone are commonly dispersed; *F. serratus* and *canaliculatus* have not yet been detected; and the *Halidrys* and *Himanthalia* rest on very uncertain evidence: so that of the *six* common European kinds, only *two* are certainly found in America. This deficiency in *Fucaceæ* is, in degree, made up for in *Laminariaceæ*, of which family several are peculiar to the American shore, the most remarkable of which is the *Agarum* or Sea Colander.

Among the red Algæ (or *Rhodospirms*), species with expanded, leaf-like fronds are proportionably less numerous than on the European side. *Delesseria sanguinea* is absent on the American shore, where its place is supplied by *D. Americana*, a species of equally brilliant colouring, but lower in organization, connecting *Delesseria* with *Nitophyllum*. This latter genus, of which there are so many fine European species, is scarcely known in North America. A few scraps of *Nitophylla* (almost too imperfect to describe), picked up at the mouth of the Wilmington

River, N. C., and at Key West, are all the evidence we at present possess of the existence of that type of form on the North American shore. *Plocamium coccineum*, so abundant in Europe, and which is also widely dispersed in the Southern Ocean, extending from Cape Horn eastwards to New Zealand, has not that I am aware of been found on the American Atlantic coast, where its place seems taken by the equally brilliant *Rhodomenia cristata*. *Ceramium rubrum* is as common on the American as on the European coast, and many of the other common American *Rhodospiræ* are natives of both continents.

The Green Algæ (*Chlorosperms*) are still more alike; but several of the American Cladophoræ (not yet fully explored) seem to be peculiar. *Codium tomentosum*, which is common to the shores of Europe from Gibraltar, in lat. 36°, to Orkney in lat. 60°, and perhaps further north, has yet been found only on the Florida Keys, (lat. 24°). Judging from its distribution in other parts of the world, particularly in the Pacific and Southern Oceans, one would have expected to find it all along the East coast of North America.

Perhaps it would be premature to indicate regions of Algæ into which the Eastern and Southern shores of the North American states may be divided, a few points only having as yet been carefully explored. Halifax Harbour, Massachusetts Bay, Long Island Sound at several points from Greenport to New York, New York Harbour, and the neighbourhood of Charleston, S. C., are the chief points at which the materials for this essay have been collected on the East coast. Our knowledge of southern Algæ is at present derived chiefly from a partial examination of the Florida Keys, by Dr. Wurdemann, Professor Tuomey, Dr. Blodgett and myself. I think it probable, however, that future researches will indicate four regions of distribution, as follows:—

1st. COAST NORTH OF CAPE COD, EXTENDING PROBABLY TO GREENLAND. Among the characteristic forms of this region are the great Laminariæ, particularly *L. Longicruris*, one of the largest Algæ on the coast, and *Agarum Turneri* and *pertusum*. Several of the rarer Fucaceæ seem also to be confined to this district. One of the most abundant and characteristic species of this tract is *Rhodomenia cristata*, which has not to my knowledge been found farther south than Cape Cod. Specimens said to have come from Staten Island have been shown to me, but the evidence on which the habitat of these rests is not satisfactory, and none of the Brooklyn and New York Algologists (a numerous and indefatigable band) have yet detected the plant in their harbour. *Ptilota plumosa* is also a plant of this region, the only species (as far as I know) that is met with in Long Island Sound being *P. sericea*, Gm. *Rhodomelæ* are more abundant here than in the Sound, but are not limited to this division; *Odonthalia* (a peculiarly northern form) has been seen only at Halifax. *Dumontia ramentacea*, so abundant at Iceland, is found also at Newfoundland, and near Halifax, where I gathered it plentifully. Of this plant I possess a single specimen, picked up by Miss Frothingham on Rye Beach, New Hampshire. All the species I have mentioned are Arctic forms confined in the European waters to very high latitudes, and all appear to vegetate nearly as far south as Cape Cod, to which limits they are almost all confined. The Marine flora of this region as a whole bears a

resemblance to that of the shores of Iceland, Norway, Scotland, and the North and North West of Ireland.

2nd. LONG ISLAND SOUND, including under this head New York Harbour and the sands of New Jersey.

The natural limit of this region on the south is probably Cape Hatteras, but after passing New York the almost unbroken line of sand is nearly destitute of Algæ. I have not received any collection of sea plants made between Long Branch and Wilmington. In comparing the plants of the sound with those of our 1st region, a very marked difference is at once seen. We lose the Arctic forms, *Agarum*, *Rhod. cristata*, *Odonthalia*, *Dumontia ramentacea* and *Ptilota plumosa*, whose place is supplied by *Sargassum*, of which genus two species are found at Greenport and at other points in the Sound; by various beautiful *Calithamnia* and *Polysiphonia*; and by abundance of *Delesseria Americana* and *Dasya elegans*. Those two latter plants are not limited to this region, but are greatly more abundant here than north of Cape Cod. *Del. Americana* seems almost to carpet the harbour of Greenport, and is equally abundant in various points in the Sound, and *Dasya elegans* grows to an enormous size in New York Harbour, and is plentiful throughout the region. *Seirospora Griffithsiana* is not uncommon; it grows luxuriantly at New Bedford, whence Dr. Roche has sent me many beautiful specimens of it, and of other *Ceramieæ*. *Rhabdonia Baileyi*, *Gracilaria multipartita*, (narrow varieties) *Chrysomenia divaricata* and *C. Rosea* are also characteristic forms. *Delesseria Leprieurii*, found in the Hudson at West Point, scarcely belongs to this region, but is a tropical form at its utmost limit of northern distribution.

3rd. CAPE HATTERAS TO CAPE FLORIDA. Of the Algæ characterizing this region we know little except those found in the neighbourhood of Charleston, and a few specimens collected at Wilmington, N. C. and at Anastasia Island. Many species found within these limits are common to the second region; others are here met with for the first time. Of these the most remarkable are *Arthrocladia villosa* and a *Nitophyllum*, found at Wilmington; a noble *Grateloupia*, probably new (*G. Gibbsii*, MS.) found at Sullivan's Island, and *Delesseria hypoglossum*, already mentioned as occurring at Charleston and Anastasia Island. I have seen no Furoid plant from this region; but if there were a suitable locality, we ought here to have *Sargassa*. None grow at Sullivan's Island, where *Grateloupia Gibbsii* is the largest sea plant, and the one most resembling a *Fucus*. All the æstuaries of this district produce *Delesseria Leprieurii*, and a *Bostrychia*, either *B. radicans*, Mont. or a closely allied species. These last are tropical forms first noticed on the shores of Cayenne, where the former was found both on maritime rocks, and on the culms of grasses in the æstuary of the Sinnamar river. With us these plants grow on the palmetto logs in Charleston Harbour, and on *Spartina glabra* as far up the river as the water continues sensibly salt. *Del. Leprieurii* was collected by Dr. Hooker at New Zealand, accompanied by a *Bostrychia*. No other habitats for it are known.

4th. FLORIDA KEYS, AND SHORES OF THE MEXICAN GULF. Here we have a very

strongly marked province, strikingly contrasting in vegetation with the East Coast, comprised in the three regions already noticed. As yet the Keys have been very imperfectly explored, and we are almost unacquainted with the marine vegetation of the main land of Florida, Alabama, Louisiana, and Texas. Of 130 species which I collected at Key West in February, 1850, scarcely one eighth are common to the east coast, seven-eighths being unknown on the American shore to the north of Cape Florida. With this remarkable difference between the Algæ of the Keys and those of the East Coast, there is a marked affinity between the former and those of the South of Europe. The marine vegetation of the Gulf of Mexico has a very strong resemblance to that of the Mediterranean Sea. Nearly one third of the species which I collected are common to the Mediterranean. Several of them straggle northwards along the coast of Spain and France, and even reach the south of England; but scarcely any of these are seen on the East coast of America. We may hence infer that they are not conveyed by the gulf-stream. My collection at Key West included 10 Melanosperms, 5 of which are common to the Mediterranean; 82 Rhodosperms, 25 of which are Mediterranean; and 38 Chlorosperms, of which 10 are Mediterranean. Besides these identical species, there are many *representative* species closely allied to Mediterranean types. This resemblance is clearly shown in the genus *Dasya*, of which *seven* out of *eleven* European species are found in the Mediterranean. At Key West I collected eight species of this beautiful genus. Among these, seven were new, and the eighth (*D. elegans*) is found along the whole eastern coast of North America. Three-fourths perhaps of the masses of seaweed cast ashore at Key West belong to *Laurencia*, of which genus several species and innumerable puzzling varieties are profusely common. A fine *Hypnea* (*H. Wurdemanni*, MS.) one of the most striking species of the genus, is also abundant. *Alsidium triangulare*, *Digenia simplex*, *Acanthophora*, *Amansia multifida* and other common West Indian Rhodosperms are abundantly cast ashore. *Sargassum vulgare* and *bacciferum*; *Padina Pavonia*; *Zonaria lobata*; and sundry *Dictyotæ* are characteristic melanosperms. But this region is chiefly remarkable for the abundance and beauty of its *Chlorosperms* of the groups *Siphonaceæ* and *Caulerpacææ*. Ten species of *Caulerpa* were collected, some of which are of common occurrence, and serve for food to the turtles, which, in their turn are the staple article of diet of the islanders. *Penicillus* (at least three species); *Udotea*; *Halimeda*; *Acetabularia*; *Anadyomene*; *Dictyosphaeria*; *Chamaedoris*; *Dasycladus*; *Cymopolia*, and others, some of which are West Indian, some Mediterranean, are evidence of the high temperature of the sea round the Keys. Many of the plants obtained by me at Key West were cast up from deeper water when the south wind blew strongly, and were not seen at any other time. A visitor, therefore, in the *hurricane months*, would probably obtain many which escaped me. Among the new species two *Delesseriæ*, (*D. involvens*, and *D. tenuifolia*) both belonging to the hypophyllous section, are specially worth notice. These were very plentiful in the beginning of February, but soon disappeared. Two *Bostrychiæ* (*B. Montagnei*, and *B. filicula*, MS.) and a *Catenella* were found on the

stems of mangroves near high water mark ; but it would extend this notice to too great a length, were I to enumerate all the forms which occur in this prolific region.

COLLECTING AND PRESERVING SPECIMENS.

I shall here reprint, for the convenience of the student, the substance of some directions for collecting and preserving specimens, issued by the Director of the Dublin University Museum.

Marine Algæ, as has already been stated, are found from the extreme of high water mark to the depth of from thirty to fifty fathoms ; which latter depth is perhaps the limit in temperate latitudes ; the majority of *deep water* species growing at five to ten fathoms. Those within the limits of the tidal influence are to be sought at low water, especially the lowest water of spring tides ; for many of the rarer and more interesting kinds are found only at the verge of low water mark, either along the margin of rocks partially laid bare, or, more frequently, fringing the deep tide-pools left at low water on a flattish rocky shore. The northern or shaded face of the tide-pool will be found richest in *red* algæ, and the most sunny side in those of an *olive* or *green* colour. Algæ which grow at a depth greater than the tide exposes, are to be sought either by dredging ; or by dragging after a boat an iron cross armed with hooks, on all shores where those contrivances can be applied ; but where the nature of the bottom, or the difficulty of procuring boats, renders dredging impossible, the collector must seek for deep-water species among the heaps of sea-wrack thrown up by the waves. After storms seaweed sometimes forms enormous banks along the coast ; but even in ordinary tides many delicate species, dislodged by the waves, float ashore, and may be picked up on the beach in a perfect state. The rocky portions of a coast should, therefore, be inspected at low water ; and the sandy or shingly beach visited on the return of the tide. In selecting from heaps we should take those specimens only that have suffered least in colour or texture by exposure to the air ; rejecting all bleached or half melted pieces.

Collectors should carry with them one or two strong glass bottles with wide mouths, or a handbasket lined with japanned tin or gutta percha, for the purpose of bringing home in *sea water* the smaller and more delicate kinds. This precaution is often absolutely necessary, for many of the *red* algæ rapidly decompose if exposed, even for a short time, to the air, or if allowed to become massed together with plants of coarser texture. The cooler such delicate species are kept the better ; and too many ought not to be crowded together in the same bottle, as crowding encourages decomposition ; and when this has begun, it spreads with fearful rapidity. These Algæ should be kept in sea water until they can be arranged for drying, and the more rapidly they are prepared the better. Many will not keep, even in vessels of sea water, from one day to another.

A common botanist's-vasculum, or an indian rubber cloth bag, will serve to bring home the larger and less membranous or gelatinous kinds ; but even these, if left long unsorted, become clotted together, and suffer proportionably.

In gathering Algæ from their native places, the *whole* plant should be plucked from the very base, and if there be an obvious root, it should be left attached. Young collectors are apt to pluck branches or mere scraps of the larger Algæ, which often afford no just notion of the mode of growth or natural habit of the plant from which they have been snatched, and are often insufficient for the first purpose of a *specimen*, that of ascertaining the plant to which it belongs. In many of the leafy Fucoid plants, (*Sargassa*, &c.) the leaves that grow on the lower and on the upper branches are quite different, and were a lower and an upper branch plucked from the same root, they might be so dissimilar as to pass for portions of different species. It is very necessary, therefore, to gather, when it can be done, *the whole plant, including the root*. It is quite true that the large kinds may be judiciously divided; but the young collector had better aim at selecting moderately sized specimens of the entire plant, than attempt the division of large specimens, unless he keep in view this maxim: every botanical specimen should be an epitome of the essential marks of a species.

Several duplicate specimens of every kind should always be preserved, and particularly where the species is a variable one. Very many Algæ vary in the comparative breadth of the leaves, and in the degree of branching of the stems; and when such varieties are noticed, a considerable series of specimens is often requisite to connect a broad and a narrow form of the same species. A neglect of this care leads to endless mistakes in the after work of identification of species, and has been the cause of burdening our systems with a troublesome number of synonyms.

Where it is the collector's object to preserve Algæ in the least troublesome manner, and in a rough state, to be afterwards laid out and prepared for pressing at leisure, the specimens fresh from the sea are to be spread out and left to dry in an airy, but not too sunny, situation. They are not to be washed or rinsed in fresh water, nor is their natural moisture to be squeezed from them. The more loosely and thinly they are spread out the better, and in dry weather they will be sufficiently dry after a few hours' exposure to allow of packing. In a damp state of the atmosphere the drying process will occupy some days. No other preparation is needed, and they may be *loosely* packed in paper bags or boxes, a ticket of the exact locality being affixed to each parcel. Such specimens will shrink very considerably in drying, and most will have changed colour more or less, and the bundle will have become very unsightly; nevertheless, if thoroughly dried, to prevent mouldiness or heating, and packed *loosely*, such specimens will continue for a long time in a perfectly sound state; and on being re-moistened and properly pressed, will make excellent cabinet specimens.

It is very much better, when drying Algæ in this rough manner, *not* to wash them in fresh water, because the salt they contain serves to keep them in a pliable state, and causes them to imbibe water more readily on re-immersion. All large and coarse growing Algæ may be put up in this manner, and afterwards, at leisure, prepared for the herbarium by washing, steeping, pressing, and drying between folds of soft paper, in the same way that land plants are pressed and dried. But with the membranous and gelatinous kinds, a different method must be adopted.

The smaller and more delicate Algæ must be prepared for the herbarium as

soon as practicable after being brought from the shore. The mode of preparation is as follows, and, after a few trials and with a little care, will soon be learned.

The collector should be provided with three flat dishes or large deep plates, and one or two shallower plates. One of the deep plates is to be filled with sea-water, and the other two with fresh water. In the dish of sea-water the stock of specimens to be laid out may be kept. A specimen taken from the stock is then introduced into one of the plates of fresh water, washed to get rid of dirt or parasites that may infest it, and pruned or divided into several pieces, if the branches be too dense, or the plant too tufted, to allow the branches to lie apart when the specimen is displayed on paper. The washed and pruned specimens are then floated in the second dish until a considerable number are ready for laying down. They are then removed separately into one of the shallower plates, that must be kept filled with *clean* water ; in which they are floated and made to expand fully. Next a piece of white paper of suitable size is carefully introduced under the expanded specimen. The paper then, with the specimen remaining displayed upon it, is cautiously brought to the surface of the water, and gently and carefully drawn out, so as not to disarrange the branches. A forceps, a porcupine's quill, a knitting needle, or an etching tool, or any finely pointed instrument will assist the operator in displaying the branches and keeping them separate while the plant is lifted from the water ; and should any branch become matted in the removal, a little water dropped from a spoon over the tangled portion, and the help of the finely pointed tool, will restore it.

The piece of wet paper with the specimen upon it is to be laid on a sheet of soft soaking paper, and others laid by its side until the sheet is covered. A piece of thin calico or muslin, as large as the sheet of soaking paper, is then spread over the wet specimens. More soaking paper, and another set of specimens covered with cotton, are laid on these ; and so a bundle is gradually raised. This bundle, consisting of sheets of specimens, is then placed between flat boards, under moderate pressure, and left for some hours. It must then be examined, the specimens on their white papers must be placed on dry sheets of soaking paper, covered with fresh cloths, and again placed under pressure. And this process must be repeated every day until the specimens are fully dry.

In drying, most specimens will be found to adhere to the papers on which they have been displayed, and care must be taken to prevent their sticking to the pieces of cotton cloth laid over them. Should it be found difficult to remove them from the muslin, it is better to allow them to dry, trusting to after-removal, than to tear them away in a half-dried state, which would probably destroy the specimens. A few dozen pieces of unglazed thin cotton cloth of proper size should always be at hand, (white muslin, that costs six or eight cents per yard, answers very well). These cloths will be required only in the first two or three changes, for when the specimen has begun to dry on the white paper it will not adhere to the soaking paper laid over it. In warm weather the smaller kinds will often be found perfectly dry after forty-eight hours' pressure, and one or two changes of papers.

USES OF THE ALGÆ.

THE uses of the Algæ may be considered under two points of view, namely; the general office which this great class of plants, as a class, discharges in the economy of nature; and those minor useful applications of separate species which man selects on discovering that they can yield materials to supply his various wants.

The part committed to the Algæ in the household of nature, though humble when we regard them as the lowest organic members in that great family, is not only highly important to the general welfare of the organic world, but, indeed, indispensable. This we shall at once admit, when we reflect on the vast preponderance of the ocean over the land on the surface of the earth, and bear in mind that almost the whole submarine vegetation consists of Algæ. The number of species of marine plants which are not Algæ proper is extremely small. These on the American coast are limited to less than half a dozen, only one of which, the common *Eel Grass* (*Zostera marina*), is extensively dispersed.

All other marine plants are referable to Algæ; the wide spread sea would therefore be nearly destitute of vegetable life were it not for their existence. Almost every shore—where shifting sands do not forbid their growth—is now clothed with a varied band of Algæ of the larger kinds; and microscopic species of these vegetables (*Diatomaceæ*) teem in countless myriads at depths of the ocean as great as the plummet has yet sounded, and where no other vegetable life exists. It is not, therefore, speaking too broadly to say that the sea, in every climate and at all known depths, is tenanted by these vegetables under one phase or other.

The sea, too, teems with animal life,—that “great and wide sea, wherein are things creeping innumerable, both small and great beasts,” affords scope to hordes of animals, from the “Leviathan” whale to the microscopic polype, transparent as the water in which he swims, and only seen by the light of the phosphoric gleam which he emits. Now this exuberant animal creation could not be maintained without a vegetable substructure. It is one of the laws of nature that animals shall feed on organized matter, and vegetables on unorganised. For the support of animal life, therefore, we require vegetables to change the mineral constituents of the surrounding media into suitable nutriment.

In the sea this office of vegetation is almost exclusively committed to the Algæ, and we may judge of the completeness with which they execute their mission by the fecundity of the animal world which depends upon them. Not that I would assert that all, or nearly all, the marine animals are directly dependant on the Algæ for their food; for the reverse is notoriously the case. But in every class we find species which derive the whole or a part of their nourishment from the Algæ, and there are myriads of the lower in organization which do depend upon them altogether.

Among the higher orders of Algæ feeders I may mention the Turtles, whose *green fat*, so prized by aldermanic palate, may possibly be coloured by the unctuous green juices of the *Caulerpæ* on which they browse. But without further notice of those that directly depend on the Algæ, it is manifest that all must ultimately, though

indirectly, depend on whatever agency in the first instance seizes on inorganic matter, and converts it into living substance suitable to enter into the composition of animal nerve and muscle. And this agency is assuredly the office of the vegetable kingdom, here confined in the main to Algæ; we thus sufficiently establish our position that the Algæ are indispensable to the continuance of organic life in the sea.

As being the first vegetables that prey upon dead matter, and as affording directly or indirectly a pasture to all water animals, the Algæ are entitled to notice. Yet this is but one-half of the task committed to them. Equally important is the influence which their growth exerts on the water and on the air. The well-known fact that plants, whilst they fix carbon in an organized form in extending their bodies by the growth of cells, exhale oxygen gas in a free state, is true of the Algæ as of other vegetables. By this action they tend to keep pure the water in which they vegetate, and yield also a considerable portion of oxygen gas to the atmosphere. I have already stated that whenever land becomes flooded, or wherever an extensive surface of shallow water—whether fresh or salt—is exposed to the air, *Confervæ* and allied Algæ quickly multiply. Every pool, every stagnant ditch is soon filled with their green silken threads. These threads cannot grow without emitting oxygen. If you examine such a pool on a sunny day, you may trace the beads of oxygen on the submerged threads, or see the gas collect in bubbles where the threads present a dense mass. It is continually passing off into the air while the *Confervæ* vegetate, and this vegetation usually continues vigorous, one species succeeding another as it dies out, as long as the pool remains. And when, on the drying up of the land, the *Confervæ* die, their bodies, which are scarcely more than membranous skins filled with fluid, shrivel up, and are either carried away by the wind or form a papery film over the exposed surface of the ground. In neither case do they breed noxious airs by their decomposition. All their life long they have conferred a positive benefit on the atmosphere, and at their death they at least do no injury. The amount of benefit derived from each individual is indeed minute, but the aggregate is vast when we take into account the many extensive surfaces of water dispersed over the world, which are thus kept pure and made subservient to a healthy state of the atmosphere. It is not only vast, but it is worthy of Him who has appointed to even the meanest of His creatures something to do for the good of His creation.

These general uses of the Algæ, apparent as they are on a slight reflection, are apt to be overlooked by the utilitarian querist, who will see no use in anything which does not directly minister to his own wants, and who often judges of the use of a material by the dollars and cents which it brings to his pocket.

It would be in vain to adduce to him the indirect benefit derived to the rest of creation through the lower animals which the Algæ supply with food; for probably he would turn round with the further demand, “what is the *use* of feeding all these animals?” And he might think, too, that the amount of oxygen in the air was quite enough to last out at least his time, without such constant renovation as the Algæ afford, or that sufficient renovation would come from other sources had the Algæ never been created. “Show me,” he would say, “how I can make money

of them, and then I will admit the *uses* of these vegetables." This I shall therefore now endeavour to do, by summing up a few of the uses to which Algæ have been applied by man.

Man, in his least cultivated state, seeks from the vegetable kingdom in the first place a supply for the cravings of hunger, and afterwards medicine or articles of clothing. As *food*, several species of Algæ are used both by savage and civilized man, but more frequently as condiments than as staple articles of consumption. Many kinds commonly found on the shores of Europe are eaten by the peasantry. The midrib of *Alaria esculenta*, stripped of the membranous wings, is eaten by the coast population of the north of Ireland and Scotland ; but to less extent than the dried fronds of *Rhodomenia palmata*, the *Dulse* of the Scotch and *Dillisk* of the Irish. This latter species varies considerably in texture and taste according to the situation in which it grows. When it grows parasitically on the stems of the larger *Laminariæ* it is much tougher and less sweet, and therefore less esteemed than when it grows among mussels and Balani near low water mark. It is this latter variety, which, under the name of "shell dillisk," is most prized. In some places on the west of Ireland, this plant forms the chief relish to his potatoes that the coast peasant enjoys ; but its use is by no means confined to the extreme poor. It is eaten occasionally, either from pleasure or from an opinion of its wholesomeness, by individuals of all ranks, but, except among the poor, the taste for it is chiefly confined to children. It is commonly exposed for sale at fruit stalls, in the towns of Ireland, and may be seen in similar places in the Irish quarters of New York. In the Mediterranean it forms a common ingredient in soups, but notwithstanding M. Soyer's attempt in the famine years to teach this use of it to the Irish, they have not yet learned to prefer it cooked. Occasionally, however, it is fried.

Chondrus crispus, the *Carrageen* or *Irish Moss* of the shops, is dissolved, after long boiling, into a nearly colourless insipid jelly, which may then be seasoned and rendered tolerably palatable. It is considered a nourishing article of diet, especially for invalids, and has been recommended in consumptive cases. At one time, before it was generally known to be a very common plant on rocky coasts, it fetched a considerable price in the market. Though called "Irish moss," it is abundant on all the shores of Europe and of the Northern States of America. It is, perhaps, most palatable when prepared as a blanc-mange with milk, but it should be eaten on the day it is made, being liable, when kept, to run to water. Its nourishing qualities have been tested, I am informed, in the successful rearing of calves and pigs partly upon it.

Many other species, particularly various kinds of *Gigartina* and *Gracilaria*, yield similar jellies when boiled, some of which are excellent.

Gracilaria lichenoides, the *Ceylon Moss* of the East, where it is largely used in soups and jellies ; and *G. Spinosæ*, the *Agar-Agar* (or *Agal-Agal*) of the Chinese, are among the most valuable of these. They are extensively used and form important articles of traffic in the East. Another species of excellent quality, the *Gigartina speciosa* of Sonder, is collected for similar purposes by the colonists of Swan River.

It was at one time supposed that the famous edible birds' nests of China, the

finest of which sell for their weight in gold, and enter into the composition of the most luxurious Chinese dishes, were constructed of the semi-decomposed branches of some Alga of one or other of the above named genera ; but it has since been ascertained that these nests consist of an animal substance, which is supposed to be disgorged by the swallows that build them.

Nearly all the cartilaginous kinds of Rhodospermeæ will boil down to an edible jelly. One kind is preferred to another, not from being more wholesome, but from yielding a stronger and more tasteless gelatine. The latter quality is essential ; for though the skill of the cook can readily impart an agreeable flavour to a tasteless substance, it is more difficult to overcome the smack of an unsavoury one. And the main quality which gives a disrelish to most of our Algæ-jellies and blanc-manges, is a certain bitterish and sub-saline taste which can rarely be altogether removed.

Very few Algæ have been found agreeably tasted when cooked, though *Dillisk* and others are pleasantly sweet when eaten raw. Many which, when moistened after having been dried, exhale a strong perfume of violets, are altogether disappointing to the palate.

Perhaps, after all, the most valuable as articles of food are the varieties of *Porphyra vulgaris* and *P. laciniata*, which in winter are collected on the rocky shores of Europe, and by boiling for many hours are reduced to a dark brown, semi-fluid mass, which is brought to table under the name of *marine sauce*, *sloke*, *slouk*, or *sloucawn*. It is eaten with lemon juice or vinegar, and its flavour is liked by most persons who can overcome the disgust caused by its very unpleasant aspect. At some of the British establishments for preserving fresh vegetables, it is put up in hermetically sealed cases for exportation and use at sea, or for use at seasons when it cannot be obtained from the rocks. It is collected only in winter, at which season the membranous fronds, which are found in a less perfect state in summer, are in full growth. Both species of *Porphyra* grow abundantly on the rocky shores of North America. They not only furnish an agreeable vegetable sauce, but are regarded as antiscorbutic, and said to be useful in glandular swellings, perhaps from the minute quantity of iodine which they contain.

As articles of food for man, other seaweeds might be mentioned, but I admit that none among them furnish us directly with valuable esculents ; though many less nauseous than the hunter's "*Tripe de Roche*," are sufficiently nourishing to prolong existence to the shipwrecked seaman ; and others, like the *Porphyra* just mentioned, are useful condiments to counteract the effects of continued subsistence on salt-junk.

But if not directly *edible*, there are many ways in which they indirectly supply the table. As winter provender for cattle, some are in high esteem on the northern shores of Europe. In Norway and Scotland the herds regularly visit the shores, on the recess of the tide, to feed on *Fucus vesiculosus* and *F. serratus*, which are both also collected and boiled by the Norwegian and Lapland peasants, and when mixed with coarse meal given to pigs, horses, and cattle. These Fuci are both grateful and nourishing to the animals, which become very partial to such food. Yet, perhaps, they are only the resources of half-fed beasts, and would possibly be

blown on by a stall-fed "short-horn" that looks for vegetables of a higher order.

To obtain such food for the high bred cow, the Algæ must be applied in another way—namely, as manure. For this purpose they are very largely used in the British Islands, where "sea-wrack" is carried many miles inland, and successfully applied in the raising of green crops. On the west coast of Ireland the refuse of the sea furnishes the poor man with the greater part of the manure on which he depends for raising his potatoes. All kinds of seaweed are indiscriminately applied; but the larger kinds of *Laminarice* are preferred. As these rapidly decompose and melt into the ground, they should, in common with other kinds, be used fresh, and not suffered to lie long in the pit, where they soon lose their fertilizing properties. The crops of potatoes thus raised being generally abundant, but the quality rarely good, sea-wrack is more suitable to the coarser than to the finer varieties of the potato. It is, however, considered excellent for various green crops, and a good top dressing for grass land, and its use is by no means confined to the poorer districts. The employment of sea-wrack is limited only by the expense of conveying so bulky a material to a distance from the sea or a navigable river.

Though the agricultural profits derived from the Algæ are considerable, a still larger revenue was once obtained by burning the *Fuci*, and collecting their ashes as a source of carbonate of soda, a salt which exists abundantly in most of them. *Fucus vesiculosus*, *nodosus* and *serratus*, the three commonest European kinds, yielded, up to a recent period, a very considerable rental to the owners of tidal rocks on the bleakest and most barren islands of the north of Scotland, and on all similar rocky shores on the English and Irish coasts. A single proprietor (Lord Macdonald) is said to have derived £10,000 per annum, for several successive years, from the rent of his *kelp* shores; and the collecting and preparation of the *kelp* afforded a profitable employment to many thousands of the inhabitants of Orkney, Shetland, and the Hebrides.

During the last European war, when England was shut out from the markets from which a supply of soda was previously obtained, almost the whole of the alkali used by soap-boilers was derived from the *kelp* or sea-weed ashes collected in Scotland. The quantity annually made in favourable years, between 1790 and 1800, amounted on the authority of Dr. Barry* to 3,000 tons, which then fetched from £8 to £10 sterling per ton; but at a later period of the war rose from £18 to £20. It is also stated by the same author that within the 80 years, from 1720 to 1800, which succeeded the first introduction of the *kelp* trade, the enormous sum of £595,000 was realized by the proprietors of *kelp* shores and their tenants and labourers.

Yet so great was the prejudice of the islanders against this lucrative trade, when first proposed to them, "and," to quote Dr. Greville, "so violent and unanimous was the resistance, that officers of justice were found necessary to protect the individuals employed in the work. Several trials were the consequences of these outrages. It was gravely pleaded in a court of law, 'that the suffocating smoke that issued from the *kelp* kilns would sicken or kill every species of fish on the

* History of the Orkney Islands, p. 383 (as quoted by Greville, see Alg. Brit. Introd. p. xxi. et seq.)

coast, or drive them into the ocean far beyond the reach of the fishermen ; blast the corn and grass on their farms ; introduce diseases of various kinds ; and smite with barrenness their sheep, horses and cattle, and even their own families.' " We smile at the ignorant bigotry of these poor people ; but have we never heard as great misfortunes predicted of almost every new improvement of the age we live in, and that not by unlettered peasantry, but by persons calling themselves wise, learned, and refined ? As sad stories have been told against temperance, free trade, or even against the exhibition in the Crystal Palace.

The Orkney islanders were not long in finding the golden harvest which had thus in the first instance been forced upon them, and within a few years " Prosperity to the kelp trade ! " was given as the leading toast on all their festive occasions. This state of prosperity lasted until the general peace, when the foreign markets being thrown open, *barilla* came into competition with the home produce. The manufacture of kelp gradually declined as the price fell, and now it has nearly ceased altogether, for besides the competition with *barilla*, the modern process by which soda is readily procured from rock-salt has brought another rival into the field, and one against which it seems in vain to contend.

Kelp is still made on a small scale for local consumption, and is sometimes exported as manure, but at a very low price. It is not likely ever to rise again into importance, except as a source of *Iodine*, which singular substance was first discovered in a soap-ley made with kelp ashes. Iodine has now become almost indispensable, from its medicinal value, as well as from its use in the arts and manufactures, and has been found in greater quantity in the fronds of certain littoral *Algæ* than in any other substances. It is therefore possible that for producing this substance these kelp-weeds may again become of mercantile importance. As a remedy in cases of glandular swellings, the use of Iodine is now well established, and it is a singular fact that several littoral *Fuci* have been from early times considered popular remedies in similar affections. *Fucus vesiculosus* has long been used by the hedge-doctors to reduce such swellings ; and Dr. Greville mentions, on the authority of the late Dr. Gillies, that the " stems of a seaweed are sold in the shops, and chewed by the inhabitants of South America wherever goitre is prevalent, for the same purpose. This remedy is termed by them *Palo Coto* (literally *Goitre-stick*)," and Dr. Greville supposes, from the fragments which he had seen, that it is a species of *Laminaria*.

Iodine however, though the most important, is not the only medicinal substance obtained from the *Algæ*. *Gracilaria helminthochorton*, or *Corsican Moss*, has long held a place in the pharmacopœia as a vermifuge. What is sold under this name in the shops is commonly adulterated with many other kinds. In samples which I have seen, the greater part consisted of *Laurencia obtusa*, through which a few threads of the true *Corsican Moss* were dispersed. Possibly, however, the *Laurencia* may be of equal value.

Mannite also has been detected by Dr. Stenhouse in several *Algæ*, to which it imparts a sweetish taste. The richest in this substance appears to be *Laminaria saccharina*, from a thousand grains of which 121.5 grains or 12.15 per cent. of mannite were obtained. The method of extracting is very simple. The dried weed

is repeatedly digested with hot water, when it yields a mucilage of a brownish red colour and of a sweetish but very disagreeable taste. When evaporated to dryness, this mucilage leaves a saline semicrystalline mass. This being repeatedly treated with boiling alcohol, yields the mannite in "large hard prisms of a fine silky lustre." *Halidrys siliquosa*, *Laminaria digitata*, *Fucus serratus*, *Alaria esculenta*, *Rhodymenia palmata*, &c. are stated by Dr. Stenhouse, from whose memoir this account is condensed, to contain from 1 to 5 or 6 per cent. of mannite.

In summing up the economic uses to which Algæ have been applied, I must not omit to mention their application in the arts. The most valuable species, in this point of view, with which we are acquainted, is the *Gracilaria tenax* of China, under which name probably more than one species may be confounded. Of this plant, on the authority of Mr. Turner, (Hist. Fuc. vol. 2, p. 142,) "the quantity annually imported at Canton is about 27,000 lbs., and it is sold in that city at about 6d. or 8d. per lb. In preparing it, nothing more is done than simply drying it in the sun; after which it may be preserved, like other Fuci, for any length of time, and improves by age, when not exceeding four or five years, if strongly compressed and kept moist. The Chinese, when they have occasion to use it, merely wash off the saline particles and other impurities, and then steep it in warm water, in which, in a short time, it entirely dissolves, stiffening as it cools into a perfect gelatine, which, like glue, again liquefies on exposure to heat, and makes an extremely powerful cement. It is employed among them for all those purposes to which gum or glue is here deemed applicable, but chiefly in the manufacture of lanthorns, to strengthen or varnish the paper, and sometimes to thicken or give a gloss to gauze or silks." Mr. Turner derived the above information respecting *G. tenax* from Sir Joseph Banks; but recent travellers tell us that *Gracilaria spinosa*, known colloquially as *Agal-agal*,* yields the strongest cement used by the Chinese, and that it is brought in large quantities from Singapore and neighbouring shores to the China markets. Probably both species are esteemed for similar qualities.

Several Algæ are used in the arts in a minor way. Thus, according to Dr. Patrick Neill, knife-handles are made in Scotland of the stems of *Laminaria digitata*. "A pretty thick stem is selected, and cut into pieces about four inches long. Into these, when fresh, are stuck blades of knives, such as gardeners use for pruning or grafting. As the stem dries, it contracts and hardens, closely and firmly embracing the hilt of the blade. In the course of some months the handles become quite firm, and very hard and shrivelled, so that when tipped with metal they are hardly to be distinguished from hartshorn."

On the authority of Lightfoot,† the stems of *Chorda filum*, which often attain the length of thirty or forty feet, and which are popularly known in Scotland as "Lucky Minny's lines," "skinned, when half dry, and twisted, acquire so considerable a degree of strength and toughness," that the Highlanders sometimes use them as fishing lines. The slender stems of *Nereocystis* are similarly used by the fishermen in Russian America. In parts of England bunches of *Fucus vesiculosus* or *F.*

* See, the Voyage of H.M.S. *Samarang*.

† Fl. Scot. vol. 2, p. 964.

Serratus are frequently hung in the cottages of the poor as rude barometers, their hygrometric qualities, which arise from the salt they contain, indicating a change of weather.

In our account of the artistic value of Algæ, we ought not to pass unnoticed the ornamental works which the manufacturers of "sea-weed pictures," and baskets of "ocean-flowers," construct from the various beautiful species of our coasts, and which are so well known at charity bazaars, accompanied by a much-hackneyed legend, commencing,

"Call us not weeds, we are flowers of the sea," &c.

Some of these "works of art" display considerable taste in the arrangement, and the objects themselves are so intrinsically beautiful that they can rarely be otherwise than attractive. During the recent pressure of Irish famine, many ladies in various parts of the country employed a portion of their leisure in the manufacture of these ornamental works, and no despicable sum was raised by the sale.

Other sums, for charitable purposes, have been realized in a way which a botanist would deem more legitimate, by the sale of books of prepared and named specimens; and my friend, the Rev. Dr. Landsborough,* I am told, has in this manner collected money which has gone a considerable way towards building a church. There seems no good reason why missionaries in distant countries might not, either personally or through their pupils or families, collect these and other natural objects, and sell them for the benefit of their mission; by which means they would not only obtain funds for pursuing the work more immediately committed to them, but would have the satisfaction of knowing that in doing so they were unfolding to the admiration of mankind new pages of the wide-spread volume of nature.

Unfortunately, it happens that in the educational course prescribed to our divines, natural history has no place, for which reason many are ignorant of the important bearings which the book of Nature has upon the book of Revelation. They do not consider, apparently, that both are from God—both are His faithful witnesses to mankind. And if this be so, is it reasonable to suppose that either, without the other, can be fully understood? It is only necessary to glance at the absurd commentaries in reference to natural objects which are to be found in too many annotators of the Holy Scriptures, to be convinced of the benefit which the clergy would themselves derive from a more extended study of the works of creation. And to missionaries, especially, a minute familiarity with natural objects must be a powerful assistance in awakening the attention of the savage, who, after his manner, is a close observer, and likely to detect a fallacy in his teacher, should the latter attempt a practical illustration of his discourse without sufficient knowledge.† This subject is too important for casual discussion, and deserves the careful consideration of those in whose hands the education of the clergy rests. These are not days in which persons who ought to be our guides in matters of doctrine can afford to be behind the rest of the world in knowledge; nor can they safely

* Author of "A Popular History of British Seaweeds."

† See some excellent observations on this subject in "Foot-prints of the Creator: or, the Asterolepis of Stromness," by Hugh Miller. London, 1849.

sneer at the "knowledge that puffeth up," until, like the Apostle, they have sounded its depths and proved its shallowness.

Why should the study of the physical sciences be supposed to have an evil influence on the mind—a tendency to lead men to doubt every truth which cannot be made the direct subject of analysis or experiment? I can conceive a one-sided scientific education having this tendency. If the mind be propelled altogether in one direction, and that direction lead exclusively to analytical research, it is possible that the other faculties of the individual may become clouded or enfeebled—and then he is the unresisting slave of analysis—not more a rational being than any other monomaniac. And yet, paradoxical though the assertion seem, he may be all his life a reasoner, forming deductions and inductions with the most rigid accuracy, in his beaten track.

I can conceive too the astronomer, conversant with the immensity of space and its innumerable systems of worlds, so prostrated before the majesty of the material creation, as not only to lose sight of himself and of the whole race to which he belongs, but of the world or even of the solar system, and be led to doubt whether things so poor, and mean, and small can have any value in the sight of the Lord of so wide a dominion. I can conceive him, too, observing the uniformity and the harmony of the laws that govern the whole system of the heavens; the undeviating course of all events among the stars coming round as regularly as the shadow on the dial; and the little evidence there is that this uniformity has ever suffered any disturbance that cannot be accounted for by the law of gravitation, and made the subject of calculation by the mathematician, who, working an equation in his closet, shall come forth and declare the cause of irregularity, though that cause may be acting at thousands of millions of miles distance—I can conceive him inferring from a uniformity like this the absence of a superintending Providence in human affairs. If the Creator, he will say, have given up the very heaven of heavens to the immutable laws of gravitation, can I believe that he interferes by his Providence to superintend the puny matters of this lower world?

His reasons seem plausible while the mind is pointed in that one direction. But they lose all their force when, laying aside for a moment the telescope, the philosopher investigates with his microscope the structure of any *living* thing, no matter how small and how seemingly simple the organism may be. Let the object examined but have *life*, and it will soon lead him to understand a little of the meaning of God's glorious title, *Maximus in minimis*. And the further he carries his researches, the more the field of research opens, until, extending from the speck beneath his lens, it spreads wider and wider, and at length blends with infinity at the "horizon's limit." Here his boasted analysis can afford him no help. He has laid bare the "mechanism of the heavens;" he has weighed the sun and the planets; he has foretold with unerring certainty events which shall happen a thousand years after he shall be laid in the dust;—and yet he cannot unravel the mystery that shrouds the seat of life, even as it exists in the meanest thing that crawls. And if the life of this poor worm be thus wonderful, what is that spirit which animates the human frame? What is that humanity which, but a moment ago, seemed like the small dust in the balance compared with the multitude and the

masses of the stars? His conceptions of his own true position in the scale of being become more rational. For a moment he views from a new position the distant stars, as the peasant views them in a clear night:—points of light spangling the blue vault above. And he reflects, “How do I *know* that those shining ones are other than they seem; how do I *know* their size, their distance, the laws by which they are governed; the reins by which the “coursers of the sun” are held in their appointed track? How?—but by the intellectual powers of that human spirit which but now I deemed so poor and mean:—so unworthy of the very thought of the Almighty—much more, so unworthy of the price which He has paid for it.”

Thus the mind, turned back upon itself, begins to discover that, after all, it is not “of the earth, earthy,” but derived from a higher source and reserved for a higher destiny. And strange to say, this altered and bettered opinion of itself is traceable to the first check which it feels—the first baffling of its analytical powers. So long as the mind was extending the sphere of its researches into the material universe, weighing, and numbering, and tabulating all nature seemed to move in blind obedience to a force whose influence might be calculated; every world being found to act upon its fellow in exact proportion to its position and its weight, and *our* world to be but a part, and a small part of one vast machine. And with such a view of the relation of the earth to the universe, might not unnaturally come a lower estimate of man, the dweller on the earth. “Is he too but a part in the house in which he dwells? Is his course also subject to those immutable laws which bind the universe together? And if so, where is his individuality? Where the reflex of that image in which he is said to have been created?” But the moment that the mind apprehends the action of the inexplicable laws of life, and is certified of the *individuality* of every living thing however small;—and compares these microscopic “wholes” with the “whole” that it feels itself to be, that moment it begins to see that the human soul is a something apart from the world in and over which it is placed.

Galileo in his cell was bound in fetters, but his spirit could not be bound. His thoughts were as free and his mind had as wide a range as if he could have flown through all space on the wings of light. And thus it is with man: prisoned for a short time in this lower world, he belongs to an order of being that no world can confine. He cannot continue stationary, nor plod for ever a dull round in the treadmill here. He must either rise above all height into communion with the Deity; or fall, bereft of hope, for ever. We must not estimate such a being by the narrow bounds of the cell which he now inhabits. We must judge of him by his intellectual powers, his aspirations, his intuitive conceptions of his own nature; and, as a spirit, all these place him, in his *individuality*, far above any plurality of mere material worlds.

I may seem to be wandering from my proper theme, but my object is to vindicate the teaching of the Book of Nature from the aspersions of the ignorant and the prejudiced. Whilst I admit that half views of natural science may lead men astray; and whilst I deplore the infidelity of scientific men, whose minds are absorbed in the material on which they work;—I deny that the study of nature has, in itself, an evil tendency. On the contrary, the study of organic nature, at least, ought to

be one of the purest sources of intellectual pleasure. It places before us structures the most exquisite in form and delicate in material; the perfect works of Him who is Himself the sum of all perfections :—and if our minds are properly balanced, we shall not rest satisfied with a mere knowledge and admiration of these wonderful and manifold works ; but, reading in them the evidence of *their* relation to their Maker, we shall be led on to investigate *our own*.

I do not assert that this study is, of itself, sufficient to make men religious. But as the contemplation of any great work of art generally excites in us a two-fold admiration—admiration of the work itself, and of the genius of its author—so a true perception of the wonders of nature includes a certain worship of the author of those wonders. Yet we may study natural objects, and admire them, and devote our whole life to elucidate their structure ; and after all may fail to recognize the being of Him who has fashioned them. Such blindness is scarcely conceivable to some minds ; yet to others, the opposite appears but the effect of a warm imagination. So inexplicable is the human mind ! The moral evidence which stirs one man to his centre brings no conviction to another. Physical truths, indeed, cannot be rationally denied ; but there is no metaphysical truth which may not be plausibly obscured or explained away by self-satisfied prejudice. Hence the inconclusiveness of all reasoning against infidelity. The failure is not in the reasons set before the mind, but in the non-acknowledgment of the imperative force of moral reasons. No man can be convinced of any *moral* truth against his will ; and if the will be corrupt, it is possessed by a blind and deaf spirit, which none can cast out until a “stronger than he” shall come.

Here I pause ; but I cannot conclude this Introduction without expressing my warm thanks to the kind friends who have aided me in my researches, both with specimens and with sympathy. To some of them I am personally unknown, and with others I became acquainted casually, during my recent tour along the shores of the United States. From all I have received unmixed kindness, and every aid that it was in their power to render. Indebted to all therefore, I am more especially bound by gratitude to my friend, Professor J. W. BAILEY, of West Point, the earliest American worker in the field of Algology. Well known in his own peculiar branch of science, he has found a relaxation from more wearing thought, in exploring the microscopic world, and his various papers on what may be called “vegetable atoms” (*Diatomaceæ*) are widely known and highly appreciated. From him I received the first specimens of United States Algæ which I possessed, and, though residing at a distance from the coast, he has been of essential service in infusing a taste for this peculiar department of botany among persons favourably situated for research ; so that either from him or through him I have obtained specimens from many localities from which I should otherwise have been shut out. To him I am indebted for an introduction to a knot of Algologists who have zealously explored the south-western portions of Long Island and New York Sounds, Messrs. HOOPER, CONGDON, PIKE, and WALTERS of Brooklyn, from all of whom I have received liberal supplies of specimens ; and through him Professor LEWIS R. GIBBES, of Charleston, whose personal acquaintance I had afterwards the happiness of making, first communicated to me the result of his explorations of

Charleston harbour, as well as the first collection of Florida Algæ which I received, and which Dr. Gibbes obtained from their collector, the late Dr. Wurdemann. Through Professor ASA GRAY, of Cambridge, Mass., long before it was my good fortune to know him personally and intimately, I received collections of the Algæ of Boston Harbour made by Mr. G. B. EMERSON, Miss MORRIS, and Miss LORING, (now Mrs. GRAY) ; also of the Algæ of Rhode Island, made by Mr. S. T. OLNEY, who has done so much to illustrate the botany of that State, and by Mr. GEORGE HUNT. My gatherings from the same coasts have since been much enriched by specimens from Dr. SILAS DURKEE, of Boston, Dr. M. B. ROCHE, of New Bedford, and Mrs. P. P. MUDGE, of Lynn.

To Professor TUOMEY, of the University of Alabama, I feel especially indebted for the care and kindness with which he formed for me an interesting collection of the Algæ of the Florida Keys, and the more so because this collection was made purposely to aid me in my present work. My friend Dr. BLODGETT, of Key West, also, since my return to Europe, has communicated several additional species, and is continuing his researches on that fertile shore. To the Rev. W. S. HORE, now of Oxford, England, (a name well known to the readers of the *Phycologia Britannica*) I am indebted for a considerable bundle of well preserved specimens, gathered at Prince Edward's Island, by Dr. T. E. JEANS ; and to the kindness of my old friend and chum, ALEXANDER ELIOTT, of the Dockyard, Halifax, I owe the opportunity of a fortnight's dredging in Halifax harbour, and many a pleasant ramble in the vicinity.

My personal collections of North American Algæ have been made at Halifax ; Nahant beach ; New York Sound ; Green Port, Long Island ; Charleston harbour ; and Key West ; and are pretty full, especially at the last named place, where I remained a month.

The few Mexican species which find a place in this work have been presented to me by Prof. J. AGARDH of Lund, and were collected by M. LIEBMAN. Those from California are derived partly from the naturalists of Capt. Beechey's voyage ; a few from the late DAVID DOUGLAS ; and a considerable number brought by my predecessor, Dr. COULTER, from Monterey Bay. I have received from Dr. F. J. RUPRECHT of St. Petersburg several Algæ from Russian America ; from SIR JOHN RICHARDSON a few Algæ of the polar sea ; and various specimens of these plants, which have found their way from the North West Coast to the herbarium of Sir W. J. HOOKER, have, with the well-known liberality of that illustrious botanist, been freely placed at my disposal.

But I should not, in speaking of the North West Coast, omit to mention a name which will ever be associated in my mind with that interesting botanical region, the venerable ARCHIBALD MENZIES, who accompanied Vancouver, and whom I remember as one of the finest specimens of a green old age that it has been my lot to meet. He was the first naturalist to explore the cryptogamic treasures of the North West, and to the last could recal with vividness the scenes he had witnessed, and loved to speak of the plants he had discovered. His plants, the companions of his early hardships, seemed to stir up recollections of every circumstance that had attended their collection, at a distance of more than half a century back from the

time I speak of. He it was who first possessed me with a desire to explore the American shores, a desire which has followed me through life, though as yet it has been but very imperfectly gratified. With this small tribute to his memory, I may appropriately close this general expression of my thanks to those who have aided me in the present undertaking.

W. H. H.

TRINITY COLLEGE, DUBLIN,
August 6th, 1851.

DIVISION INTO GROUPS OR SERIES.

For purposes of classification the Algæ may be conveniently grouped under three principal heads or sub-classes, which are, for the most part, readily distinguishable by the colour of the frond. They are named and defined as follows, viz.

1. MELANOSPERMEÆ. *Plants* of an olive-green or olive-brown colour. *Fructification* monœcious or diœcious. *Spores* olive-coloured, either external, or contained, singly, or in groups, in proper conceptacles; each spore enveloped in a pellucid skin (*perispore*), simple, or finally separating into two, four, or eight *sporules*. *Antheridia*, or transparent cells filled with orange-coloured, vivacious corpuscles, moving by means of vibratile cilia. *Marine*.
2. RHODOSPERMEÆ. *Plants* rosy-red or purple, rarely brown-red, or greenish-red. *Fructification* of two kinds, diœcious :—1, *Spores* (*gemmales*, Ag.) contained either in external or immersed conceptacles, or densely aggregated together and dispersed in masses throughout the substance of the frond: 2, *Spores*, commonly called *tetraspores* (*gemmales*, Thw.), red or purple, either external or immersed in the frond, rarely contained in proper conceptacles; each spore enveloped in a pellucid skin (*perispore*), and at maturity separating into four *sporules*. *Antheridia* (not observed in all) filled with yellow corpuscles. *Marine, with one or two exceptions*.
3. CHLOROSPERMEÆ. *Plants* grass-green, rarely a livid purple. *Fructification* dispersed through all parts of the frond; every cell being capable of having its contents converted into spores. *Spores* (*Sporidia*, Ag.) green or purple, formed within the cells, often (always?) at maturity vivacious, moving by means of vibratile cilia. *Gemmales* (*Coniocystræ*, Ag.) or external vesicular cells, containing a dense, dark-coloured, granular mass, and finally separating from the frond. *Marine, or, more frequently, living in fresh-water streams, ponds, and ditches, or in damp situations*.

MELANOSPERMEÆ, OR OLIVE-COLOURED ALGÆ.

SYNOPSIS OF THE ORDERS OF MELANOSPERMEÆ.

* *Frond leathery or membranaceous, forming a compact cellular substance.*

1. FUCACEÆ. *Spores* contained in spherical cavities of the frond.
2. SPOROCHNACEÆ. *Spores* attached to external, jointed filaments, which are either free, or compacted into knob-like masses.
3. LAMINARIACEÆ. *Spores* forming indefinite, cloudlike patches, or covering the whole surface of the frond.
4. DICTYOTACEÆ. *Spores* forming definite groups (*sori*) on the surface of the frond.

** *Frond formed of jointed filaments, which are either free, or united into a compound body.*

5. CHORDARIACEÆ. *Frond* cartilaginous or gelatinous, composed of vertical and horizontal filaments interlaced together. *Spores* immersed.
6. ECTOCARPACEÆ. *Frond* filiform, jointed. *Spores* external.

ORDER I.—FUCACEÆ.

J. Ag. Sp. Alg., vol. I, p. 180 ; *C. Ag. Syst. Alg.* p. xxxvii, (in part) ; *Endl. Gen. Pl.*, Suppl. 3, page 29 (excl. gen.). *Harv. Man. Br. Alg.*, ed. 2, p. 11. FUCOIDEÆ, *Grev. Alg. Brit.* p. 1 ; *Harv. Man.*, ed. 1, p. 1. FUCEÆ, CYSTOSEIREÆ, SARGASSEÆ, and HALOCHLOÆ, *Kütz. Phyc. Gen.*, p. 349, et seq. FUCIDÆ and CYSTOSEIRIDÆ, *Lindl. Veg. King.*, p. 22.

DIAGNOSIS. Olive-coloured, inarticulate seaweeds, whose spores are contained in spherical cavities of the frond. (*Plants of large size, tough, of leathery texture, becoming dark-coloured in drying.*)

NATURAL CHARACTER. *Root* almost always a conical holdfast, adhering by its base to rocks and stones, usually simple and undivided ; in a few instances sending off lateral creeping branches, and forming a mat, from which many upright fronds arise.

Fronds of large size, inarticulate, leathery or rarely in parts thin and membranaceous ; tough, tearing with facility in a longitudinal direction ; of an olive-brown or olive-green colour, becoming foxy in age, and changing to a dark brown or black in drying ; composed of minute, coloured, or colourless cells arranged in filaments, and closely united together by a very firm intercellular substance.

The *habit* is very various. In the least perfect genera (as *Splachnidium*) there is no distinction of stem, leaves, and organs of fructification, but the frond consists of a leathery bag, filled with loose jelly, through which a few longitudinal filaments pass. The spore-cavities are dispersed beneath the pores of the whole surface, and the frond is thus reduced to a root, and a universal receptacle of fructification.

In others (*Durvillæa*, *Sarcophycus*) there is a stem which gradually expands at the summit into a leaf-like, cloven lamina, through which the spore-cavities are scattered ; these genera have the habit of *Laminariæ*, but the fructification of *Fucaceæ*.

In the next stage of development (*Myriodesma*, *Carpoglossum*,) the frond becomes more leaf-like, but the spore-cavities are still dispersed equally through all its divisions.

To such forms succeeds *Himanthalia*, in which there is a clear distinction between the frond and the receptacle of fructification, but wherein the former is reduced to a cup-like air-vessel, while the latter is much branched and constitutes the bulk of the plant. In this case the true relations of the parts are determined by the

development; the cup-like frond being wholly formed and perfected before the branching fructification begins to be evolved.

Rising to still higher types of the Order we find (in *Fucus*, *Halidrys*, *Cystoseira*, &c.,) plants with branching, pinnate, or more commonly, dichotomous stems, either filiform or imperfectly leafy, having usually their leaf-like portions strongly midribbed, and forming their fructification in portions of the branches; generally in the extremities, which at first resemble ordinary parts of the frond, but afterwards swell, become succulent, and are converted into more or less distinct *receptacles*.

Lastly, (in *Sargassum*, and its allies,) there is a branching stem; distinct midribbed, rarely ribless, leaves, which are, in a few instances, decurrent, developed in a distichous or subspiral order; and receptacles which are, from their origin, set apart as organs of fructification (not formed by swellings of the branches,) and placed, either in the axils or along the edges of the leaves or branches.

In a large number of the plants of this Order, *air vessels* (*vesiculæ*) or floats designed to give buoyancy to the stem and branches, are present. In the least perfect, (as in *Himanthalia*, *Fucus*, and *Cystoseira*) the air vessels are formed by simple swellings of portions of the branches, the swollen portion becoming hollow and filled with air. In *Halidrys* several of these hollow swellings placed close together in the ramuli become confluent into a compound moniliform vesicle, which is evidently only an extreme development of the chained vesicles of *Cystoseira*. In *Phyllospora* the air vessel is formed in the leaf-stalk, the lamina being a crest to its summit. Such is likewise the case in *Sargassum*, the highest type in the order, but in this genus the lamina of these vesicular leaves is either wholly abortive or reduced to a slender mucro; so that here the air vessel appears like a distinct organ. It usually accompanies the receptacles of fructification, and is, in fact, properly a floral leaf or bract, interposing between the ordinary leaves and those appropriated to the fructification.

On most parts of the frond, but especially on the expanded portions of the stem in the less organized types, and on the leaves in the more fully developed ones, will be found minute dot-like *pores*, from which, while the plant is under water and in a growing state, a pencil of delicate, colourless, jointed hairs is seen to protrude. These pores, called the *muciferous pores* by early writers, are found in all the *Fucaceæ*, and are one of their most definite characters. Under each pore is placed a minute hollow chamber, of a spherical form, from the inside of whose walls the colourless fibres originate. It is possible that these hairs may exercise an important physiological office, acting on the aerated water as the stomates of aerial leaves do upon the air; nothing, however, has been ascertained on this point. But whatever be the use of these hollow chambers and their contents in the vegetating parts of the frond, in those appropriated to fructification they are enlarged, and transformed into the *spherical cavities* within which the *spores* and *antheridia* are lodged.

In the less organised genera, as has been already mentioned, the *spore-cavities* (*scaphidia*, Ag.—*conceptacula*, Mont.—Endl.—*angiocarpia*, Kütz.) are dispersed over the whole frond; in the more perfect, they are confined to limited portions of the

branches or leaves, which then become succulent and full of slimy mucus ; and in the highest types, small metamorphosed branchlets are from the beginning set apart as organs of fructification. These metamorphosed branchlets, or the swollen parts of ordinary branches which are filled with spore-cavities, are called *receptacles* ; (*receptacula*, Ag.—Endl.—*carpomata*, Kütz.)

Each *spore cavity*, placed immediately beneath the outer wall of the frond, and communicating freely with the water through its pore, is a hollow, spherical, membranous, bag-like chamber, whose inner surface is clothed with pellucid hairs (*paranemata*), among which organs of fructification of two kinds (male? and female) are placed. Sometimes both kinds or sexes are found in the same cavity ; sometimes all the cavities of one plant produce one kind only, and all those of another plant the other kind. (A vertical section of one of the female spore-cavities of *Fucus furcatus*, figured at our Plate III. A, fig. 4, will show the general appearance of the fructification.)

The *spores* are lodged within colourless, glassy *perispores*, or large, swollen, membranous, closed cells, attached to the walls of the cavity ; each perispore containing from one to eight, and most commonly four *spores*. The *perispore* originates, like the hairs or *paranemata*, from the wall of the cavity, and appears to be formed from one of these hairs, which, having been fertilized at an early period of its development, instead of continuing to grow by the production of new cells at its apex, like an ordinary hair, has been arrested at the first or second cell ; and this cell, becoming enlarged, has an endochrome gradually elaborated within it, and finally either condensed into a single spore or divided into several. In an early stage the colouring matter, or endochrome, is of a very fluid substance, and pale olive hue. Gradually it becomes darker and more opaque, its particles lying closer together, and at length is partially solidified and invested with a delicate membranous envelope, which constitutes the testa of the spore. In *Halidrys*, *Cystoseira*, and several other genera, each perispore contains at maturity but a single spore ; in *Fucus* and others, the number of spores varies from two to eight, or perhaps a larger number.

The *paranemata* are either simple or branched. Those which produce *Antheridia* are always branched, and the antheridia are formed from the terminal cell of each branchlet, which is enlarged and ovate, obovate, or club-shaped. This *Antheridium*, or supposed male, is a pellucid, enlarged, closed cell, containing a multitude of minute *corpuscles* (*sporidia*, Ag.), which are supposed to represent the pollen, if not to fulfil its office in fertilizing the spore. They are oval, somewhat pointed at one end, and contain a reddish-orange granule ; and they are furnished with two extremely slender vibratile hairs or *cilia*, one of which issues from the narrow extremity of the corpuscle ; the other, which is of greater length, from the coloured granule. The corpuscles, at first contained within the antheridium, at length issue from it, escaping into the surrounding water, and immediately commence a succession of rapid movements to and fro, and in circles and curved lines, strikingly similar to the ciliary movements of some of the Infusoria, or of the spores of some of the fresh water Algæ of the *Green* series. These movements depend on the rapid vibrations of the cilia. During progression, the narrow end of the cor-

puscle is always in front; while the cilium, rising from the coloured granule, trails behind like a tail.

Messrs. Decaisne and Thuret, from whose memoir (*in Ann. des Sc. Nat.* 1845, p. 5 *et seq.*) this description is mostly taken, point out the strong analogy between these vivacious corpuscles of the *Fucaceæ* and the so-called spermatozoa of the Characeæ, Mosses, and Hepaticæ, and argue from this similarity of structure a similarity of function. They are, therefore, of opinion that the corpuscle-bearing cells are properly organs of a similar nature to the antheridia of other cryptogamic plants; and not, as is supposed by Agardh, analogues of the sporidia of the lower Algæ, and like them capable of germination. From my own investigations, I am disposed to agree with the opinion which regards them as male organs. They may readily be seen with the higher powers of the compound achromatic microscope; and are easily found in the ordinary shore Fuci, (*Fucus vesiculosus* and *F. nodosus*), in winter or early spring, on specimens bearing bright yellow or orange coloured receptacles. Some of the most deeply coloured should be selected and placed in the air till partially dry. As the frond dries, little drops of a slimy, bright orange fluid will ooze out from the pores of the receptacle; and if one of these drops be removed, and placed in a little sea water on the stage of the microscope, it will be found to consist of multitudes of detached antheridia. If these be watched for a short time, the vivacious corpuscles may be seen to issue from them and perform their singular dances.

The *Fucaceæ* are readily known from all other orders of Melanosperms, by having their spores contained in those little spore-cavities, which we have already described. In no other order do such cavities exist.

The group of plants defined by this character is a very extensive one, comprising, perhaps, one-half of the known MELANOSPERMS. If we view it as also composed of an aggregate of individuals of each species, its relative importance will appear very much greater, for most of the plants of which it consists are *social* ones, and clothe very large portions of the submarine soil. About 230 species are described by Agardh in his last work, while Kützinger, (who has introduced many species which are not admitted by other writers) enumerates upwards of 300. Of this large number, however, I am only able to claim 20 as inhabiting the American shores, and six of these are known only on the Pacific coasts.

The deficiency of *Fucaceæ* is a very remarkable feature of the American marine flora, the common fuci of the eastern coasts being only two, (*Fucus vesiculosus* and *nodosus*) and these two scarcely growing south of New Jersey. No doubt the long line of sandy shore which extends from New York Bay southward forbids the production of plants whose natural habitat is on tidal rocks and boulders; but it is remarkable that on the rock-bound coasts of the North Eastern States, there is no trace of the *Fucus serratus* or *F. canaliculatus* which are so widely dispersed on the European side of the Atlantic. We should not consider this absence of common European forms remarkable, if the Fuci found on the American coasts were *peculiar* to them. It is because the two species so abundant in America are also common in Europe, that we wonder at the absence, in the western waters of the Atlantic, of the equally common forms with which they are associated in the eastern.

The *Fucaceæ* are rarely deep-water plants. One species (*F. canaliculatus*), common in Europe, begins to grow at the extremity of high water mark, in places where it is exposed to the atmosphere during the greater part of the twenty-four hours, and only submerged by the highest tide waves. In such places, though its growth is dwarfish, it frequently produces fruit. As it descends in depth toward mid-tide level, the frond becomes larger and more luxuriant, and in the space between this limit and that of quarter-tide, the greater number of individual plants occur. Few straggle into deeper water. This species, of all others, is best fitted to resist drought, its fronds being peculiarly dense and leathery; and in a warm day it frequently becomes crisp and dry, and to all appearance baked to death, during the recess of the water; and yet, on the return of the tide, the withered fronds expand and become flexible and juicy. Perhaps the non-occurrence of this plant on the American coasts may be owing to the fiercer heats which it would be subjected to, in the exposed places that it would naturally occupy.

With the slight exception of this semi-aerial species, all the ordinary *Fucaceæ* are characteristic of the space strictly defined by the tide marks, extending through the whole range of exposed rock; over which in temperate latitudes they usually spread so densely, that the colour of the sea-shore is as clearly characterised by them, as is the colour of the ground by the species of grasses which constitute its green mantle.

A few of the most highly developed genera (*Cystoseira*, *Sargassum*, &c.) are productions of deeper water, commencing to grow at depths at which the *Fuci* cease, and extending into a zone of depth where they are constantly submerged. I am not aware that any species has been traced into a deeper zone than that occupied by *Laminariæ*.

One remarkable species of the genus *Sargassum* has long been famous by the name of *Gulfweed* or *Sargazo* (*sea-lentils*), under which most voyagers since the days of Columbus have spoken of it. That great discoverer was the first to encounter it in modern times, (16th September, 1492) and with his account we are therefore most familiar; but possibly the weedy sea which Aristotle speaks of as having been met with by the Phœnicians, at the termination of their voyage, may have been an early discovery of the same bank. It is curious that the great bank which extends between the 20th and 45th parallels of north latitude, and in 40° W. from Greenwich, appears to occupy the same position at the present day as it did in the days of Columbus. Between this bank and the American shores, various smaller strata and detached masses of seaweed occur, being thrown into this portion of the ocean by the eddy caused by the sub-circular motion of the great oceanic currents. The whole of this immense space of ocean, which is reported to be thickly covered with seaweed, is computed by Humboldt at upwards of 260,000 square miles, an area almost six times as large as Germany;* but it is not to be supposed that all this space is *equally* clothed with floating verdure. In many places the weed occurs in distant and narrow ridges, leaving spaces of clear water between. This portion of the Atlantic seems to be the chief *settlement* of the

* Johnst. Phys. Atlas. *Atlantic*, p. 5.

Sar. bacciferum, but straggling specimens occur in the Pacific and Indian Oceans, and on the shores of Australia and New Zealand ; and some few, carried northward by the Gulf stream, reach the northern shores of Europe in safety.

Naturalists have been puzzled to account for the origin of the Gulfweed, and formerly it was supposed to be altogether derived from the Gulf of Mexico ; being torn off the shores of the Florida reefs and keys, and carried to sea with the great current. It is possible (and indeed probable) that the *origin* of the present floating banks may have been partly of this nature, but it is most certain that the great masses of the weed that are at present found floating have had no such immediate parentage, but are produced on the surface of the ocean on which they float. Whoever has picked up the plant at sea, on any genuine portion of the bank, must have seen that it was in a perfectly fresh and growing state, and if he have looked at his specimen carefully, he will probably have observed, that different parts of the same specimen were of very different ages ; that though there was no apparent root, yet that toward the centre of the mass a small portion of stem was of a much darker colour than the rest, and possibly covered by parasitic incrustations ; and that all the branches springing from this central piece were successively more and more delicate and of paler colour, and evidently in a young and sprouting state. Such a specimen is clearly in vigorous life, yet it has no *root*. But the absence of root is a matter of very trivial moment in a seaweed ; for we must bear in mind that the roots of Algæ are merely holdfasts, intended to keep them from being washed off the rocks on which they grow. And in a plant capable of enduring extensive change of place, like this *Sargassum*, the root is the part which may be most readily dispensed with. No doubt the specimen under examination originated in a little branch accidentally broken from a neighbouring mass, and which being thus cast adrift, continued to push out new branches and leaves. In this manner, by the continual breaking up of old fronds and the continued growth of their broken parts, the floating masses spread over the surface of the sea.

In this floating state the species never forms proper fructification. There is, therefore, no growth from spores. The supply of plants is consequently kept up and extended by the constant development of buds or *gemmae*, originating in broken fragments of branches. I have taken some pains to examine numerous specimens, picked up on various parts of the bank, while fresh from the sea, and have in general been able to convince myself that the tuft under examination had originated in a fragment of an older tuft.

This process of growth by breakage must have gone on for ages ; from that early time when the first individuals were brought from some unknown rocks by the currents of the ocean. Humboldt indeed conjectures that between the parallels of 20° and 45° there is an immense bank from which the supply of *Sargassum* is constantly derived ; but such a bank, if covered by only as much water as the *greatest* depth at which any Fucaceous plant is known to grow, could scarcely have escaped the notice of voyagers. And the aspect of this *Sargassum*, with its innumerable floating-bladders, shews that it was not intended to vegetate at any great depth ; for we invariably find the air-vessels most numerous in species which rise to the surface, and altogether absent in those which are deeply submerged.

The geographical range of the Order *Fucaceæ* is very extensive. The great bulk of the species occur within 35° of the equator on either side, within which limits also the generic types are most varied. To the north of 35° *Sargassa* become rare, and on the American shore the highest limit attained by any of this genus is in Long Island Sound, about 44°. Beyond this limit the genus *Fucus* becomes the prevalent form, and in the extreme north *Himanthalia* appears. *Cystoseira*, which has many representatives in the south of Europe, four of which extend as far as Great Britain, is not found on the eastern shores of America, and but slightly, represented on the north western. It forms an intermediate link, in structure and distribution, between the tropical and arctic forms of the order. Very few species have been traced into the Antarctic Ocean, where the most remarkable form is the gigantic *Durvillaea*, which has a stipe and habit resembling a *Laminaria*; or it may be likened to a great Palm-leaf. The shores of Australia are peculiarly prolific in plants of this order, and the species of that sea are remarkable as well for their beauty, as for the large number of generic types which they exhibit. It is on those shores that the most fully organised types of the olive-coloured Algæ are met with.

In an economic point of view, the *Fucaceæ* take a high place among sea-plants. Their ashes contain a large quantity of carbonate of soda, for which the Fuci were formerly very much sought after, and even *cultivated* on some parts of the coasts of Scotland where they did not grow naturally;—rocks being deposited to attract them to pebbly or sandy shores. At one time the proprietors of sea-shores on the most barren islands of Scotland drew a very large revenue from the sale of the *wrack* (varec) or sea-ware, which was then burned and its ashes sold under the name of Kelp:* but improvements in chemistry, by which carbonate of soda is now cheaply obtained from other sources, have almost destroyed the kelp trade. These seaweeds are now collected chiefly for manure, for which purpose they are often very valuable.

Iodine is their most remarkable constituent, and is found in their tissues in greater quantity than in any other of its known sources. The increasing demand for this valuable substance may, therefore, be expected to cause a partial revival of the kelp trade.

The ordinary species, *F. vesiculosus*, is eagerly eaten in winter by Scotch and Norwegian cattle, which regularly come down to the shore to browse on it at the recess of the tide; and Linnæus tells us that in Gothland the peasantry boil it, and adding some coarse flour, give it to their hogs.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

* *Frond branched, leafy. Air-vessels stalked, separate.*

I. SARGASSUM. *Receptacles racemose, in the axils of the upper leaves.*

* See Introduction, supra, p. 35.

- ** *Fron*d branched, imperfectly leafy or pinnatifid. *Air-vessels* formed in certain parts of the leaves or branchlets.
- II. PHYLLOSPORA. *Leaves* distichous, nerveless. *Air-vessels* formed in the petioles of the leaves.
- III. HALIDRYS. *Fron*d pinnatifid, leafy below, filiform above. *Air-vessels* formed in the ultimate branchlets, podlike, of several air-cells.
- *** *Fron*d branched, imperfectly leafy or filiform. *Air-vessels* either absent, or formed irregularly by the occasional swelling of the branches.
- IV. CYSTOSEIRA. *Fron*d much branched, bushy; the branches filiform. *Receptacles* filiform, slender, terminal; their substance formed of small cells.
- V. FUCUS. *Fron*d dichotomous, flat or compressed. *Receptacles* filled with mucus, which is traversed by a net-work of jointed filaments.
- **** *Fron*d reduced to a top-shaped, or cup-shaped vesicle.
- VI. HIMANTHALIA. *Receptacles* strap-shaped, dichotomously branched.

I. SARGASSUM, Ag.

Root a conical disc. *Fron*d much divided; having a distinct stem, branches, leaves, air-vessels, and receptacles. *Branches* filiform or flat, alternate, lateral, more or less distinctly pinnate. *Leaves* horizontal, or very rarely vertical and decurrent, mostly furnished with a midrib, and muciferous pores. *Air-vessels* stalked, axillary, formed from transformed leaves, pointless or tipped with a slender process. *Receptacles* small, linear, tuberculated, axillary, racemose or dichotomous, composed of a densely cellular substance; having numerous pores, beneath which are placed the spherical conceptacles (or spore cavities.) *Spore-cavities* mostly dioecious. *Spores* one or more in each conceptacle, to whose walls they are attached, obovoid, subsessile, having a hyaline perispore. *Antheridia* roundish, on branched filaments, racemose. *Paranemata* simple or forked, clothing the walls of the conceptacle.

The frond originates in a single leaf, having a lamina and midrib. This first leaf lengthens, and either continues undivided or becomes forked at the extremity. Afterwards the lamina gradually disappears from the lower portion, while the midrib thickens and becomes the commencement of the future stem; and the upper portion, still extending, is again divided and each of its divisions forms the starting point of a branch. All the young stems and branches, which in this manner are formed out of the midrib of the first formed leaves, are in their early growth winged with the remains of the lamina of the transformed leaf; but as this soon decays away and is not renewed, the branches as they extend upwards become

quite filiform, and their upper divisions are, in the majority of species, never winged. In a few species, the wing-like border is continued through all portions of the frond. The *leaves* which clothe the branches, the only leaves generally seen on full grown plants, are formed by dilatations of ultimate barren branchlets, and therefore arise in a manner the reverse of the primary leaves which spring from the root. The root-leaves, by losing their lamina, form the commencement of the filiform stem and branches ; and again, the barren apices of the stem and branches, by acquiring a lamina, become ordinary leaves. The branching throughout the frond, which at a hasty inspection seems to be alternate, or repeatedly pinnate, is in truth but a concealed form of dichotomous division, in which every alternate prong of the fork is stopped, while the twin prong is lengthened and again forked at its extremity. It is easy to see how an alternately pinnate frond, with a zigzag rachis, would result from the continual repetition of such a system of branching. In some species with zigzag stems and branches this mode of division is very evident throughout ; but in ordinary forms, as in our *S. Montagnei* (Plate I. f. A. 1.) the truly dichotomous division of the frond is only to be clearly perceived in the lesser fertile branches. If, however, these be carefully traced back to older portions, or the development of a young plant from its first leaf watched, the alternate suppression of parts will be very evident. From the same figure it may be seen, that the air-vessels are nothing but *leaves* in which the lamina has become inflated, while the apex of the midrib is prolonged into a mucro. In other species the transformation of the vesicated leaf is less complete, and then a wing-like border surrounds the inflated portion. These vesicles are usually placed between the ordinary leaves and the receptacles of fruit, and are, therefore, to be regarded as a form of bracts, or appendages to the inflorescence. They are most numerous in species which grow in shallow water, and serve to buoy up the branches. The *receptacles* of the fructification are, in like manner, but altered leaves ; and, as in flowering plants, they are the *ultimate* leaves. The frond which originated in a *spore* has passed through the various stages of its development, and at the end of its upward growth it again forms *spores* from which new plants may germinate.

The number of species of the genus *Sargassum* is very considerable ; upwards of 120 have been described, and probably many more remain uncharacterised in various herbaria. They are chiefly tropical and sub-tropical, and are found in the oceans of both the eastern and western hemispheres, but seem to be most numerous in the former. The following are all that I have been able to ascertain as natives of North America :—

1. *SARGASSUM vulgare*, Ag. ; stem filiform, smooth or nearly so ; leaves linear or oblong-lanceolate, serrated, ribbed, brownish-olive, with evident glands ; air-vessels pointless, spherical, on compressed stalks which are as long as the air-vessel ; receptacles axillary, repeatedly forked, filiform, tuberculated, twice as short as the subtending leaf.—*J. Ag. Sp. Alg.* vol. 1, p. 342 ; *Grev. Alg. Brit.* t. 1 ; *Harv. Phyc. Brit.* t. 343. *Fucus natans*, Turn. Hist. Fuc. t. 46 (excl. vars.) *Eng. Bot.* t. 2114.

HAB. On rocks and stones near low-water mark. Perennial. Summer. Common on the Florida Keys ; thrown up from deep water abundantly at Key West ; growing within tide marks at Sand Key. At Green Port, Long Island, *Prof. Bailey*. Also at Seaconnot, Bristol Ferry and Stone Bridge, Rhode Island, *Prof. Bailey*, and *Mr. Thurber*. Narragansett Pier, Newport, and Seaconnot Point, Rhode Island, *Mr. S. T. Olney* (v. v.).

Stem from one to two feet long or more, generally undivided, but densely clothed throughout its length with lateral branches, the lowermost of which are longest, the upper gradually shorter, and those near the summit but rudimentary ; terete, from a quarter to half a line in diameter, unarmed, and usually quite smooth. *Branches* similar to the main stem, either leafy, or furnished with a set of alternate secondary branches, similar to the primary. *Leaves* of a thickish substance and coriaceous texture, having many evident glandular pores, sharply serrate, or rarely repandodentate or subentire : slightly narrowed at the base, and usually tapering to the point, but very variable in size, and in proportionate length and breadth ; sometimes oblong, sometimes linear-lanceolate, and sometimes broadly lanceolate : furnished with a strong, percurrent mid-rib, which becomes less evident just below the apex. *Air-vessels* numerous, particularly on the upper branches, and beneath the fructification, spherical, pointless, (or rarely with a small mucro), from two to three lines in diameter, raised on compressed or flattened, sometimes winged petioles of their own length. *Receptacles* axillary, linear, repeatedly forked, shorter than the subtending leaf, tuberculated. *Colour* varying from a dark, brownish olive to a foxy or tawny bay. *Substance* tough and leathery.

2. SARGASSUM *Montagnei*, Bailey MSS. ; stem filiform, slender, smooth ; leaves very narrow, linear-lanceolate, attenuate, repandodentate or subentire, ribbed, pale-greenish olive, membranaceous, glandular-dotted ; air-vessels spherical, furnished with long, filiform or foliaceous points, raised on square petioles of their own length ; receptacles axillary, tuberculated, more or less forked, and generally shorter than the subtending leaf.—(TAB. I. FIG. A.)

HAB. On rocks and stones, near low-water mark. Perennial. Summer. At Greenport, Long Island, growing with *S. vulgare*, *Prof. Bailey* and *W. H. H.* ; Little Compton, Rhode Island, *Mr. Olney* (v. v.).

Root a conical disk. *Radical* and primary leaves oblong or lanceolate, 2-3 inches long and 3-4 lines in diameter, sharply serrate or unequally dentate, membranaceous. *Stems* from two to three feet long, filiform, smooth, very slender, undivided, set throughout with lateral branches, the lowest of which are twelve or fourteen inches in length, and the upper gradually shorter and less compound. The longer branches give off alternate branchlets, at intervals of half an inch to an inch. *Leaves* of the branches very narrow, usually two inches or more in length, and only a line or two in breadth, linear-lanceolate, attenuate, sometimes nearly entire,

sometimes remotely dentate or merely repand, delicately membranaceous, of a very pale greenish olive colour, minutely glandular, furnished with a percurrent midrib. *Air-vessels* globose or slightly oval, on slender, square stalks, tipped either with a long filiform point or with a linear-lanceolate leaf, either of which is often deciduous. *Receptacles* axillary, filiform, tubercular, more or less forked, sometimes attenuate. *Colour* pale. *Substance* delicate.

My specimens, from which the plate has been drawn, were gathered in August, when many of them had formed receptacles. The fruit figured is scarcely mature. The receptacles eventually become more filiform, and repeatedly forked. I have received from Professor Bailey a fragment of a fertile branch of a Sargassum, destitute of leaves and therefore doubtful, but which probably belongs to this species. In it the receptacles are very much lengthened, slender, tassel-like, an inch and half long and repeatedly forked, and have something the aspect of the fructification of *Lycopodium Phlegmaria*. Should future observations on the spot, made later in the season, show that these very long receptacles are the ordinary state of the ripe fruit, it will materially strengthen the specific character. Professor J. Agardh mentions a var. of *S. vulgare*, which he calls *trichocarpum*, distinguished by similar tassel-like fruit. This species is dedicated by Professor Bailey to our mutual friend and fellow student, Dr. Montagne, of Paris. The *S. vulgare* var. *tenuifolium* of Mr. Olney's list ought, at least in part, to be referred to *S. Montagnei*.

3. *SARGASSUM affine*, J. Ag.; "stem filiform, smooth, leaves lanceolate-linear, acutely serrate, with a single row of glandular pores at each side of the midrib; air-vessels spherical, pointless, on subterete stalks of their own length; receptacles axillary, forked, racemose, cylindraceo-lanceolate, warted, unarmed." *J. Ag. Sp. Alg. vol. 1. p. 343.*

HAB. In the West Indian Sea. *J. Agardh.* (v. s. in Herb. Trin. Coll. Dublin.)

I introduce this, as it may probably be found on some of the Florida Keys. It seems to be intermediate in character between *S. vulgare* and *S. bacciferum*.

4. *SARGASSUM bacciferum*, Ag.; stem filiform, smooth; leaves linear-lanceolate, attenuate, sharply serrate, ribbed, usually destitute of glandular pores; air-vessels on subterete stalks, spherical, tipped with a filiform point; receptacles axillary, forked, cylindrical, warted, unarmed. *J. Ag. Sp. Alg. vol. 1. p. 344; Kütz. Sp. Alg. p. 609; Harv. Phyc. Brit. t. 104. Fucus bacciferus, Turn. Hist. Fuc. t. 47.*

HAB. Floating in the Gulf-stream, and thrown up abundantly on the Florida Keys, and on other parts of the coast. (v. v.)

The floating fronds generally grow from a central point, from which branches

extend in all directions. In such specimens the base appears to be a fragment of broken branch, rather than a true disciform root. *Branches* smooth, zigzag, or angularly bent, once or twice divided in an alternate manner, the lesser branches set with distichous leaves, having a vesicle in the axil of each. *Leaves* from two to three inches in length and from one to three lines in width, coriaceous, sharply serrate, tapering to each end, furnished with a strong midrib, but usually destitute of glandular pores. The serratures are often duplicate. *Air-vessels* very numerous, about as big as peas, spherical, mostly mucronate, tipped with a longish bristle; their stalks about as long as the inflated part, and roundish. *Receptacles* rarely found. *Colour* when quite fresh a pale and beautifully clear olive; but soon changing and becoming foxy in age and very dark in drying. *Substance*, when living, brittle.

This is the common *Tropical Sea-grape*, whose air-vessels, resembling berries, are popularly taken for fruit. It has already been spoken of as the famous *gulfweed* of navigators.*

5. SARGASSUM *Liebmanni*, J. Ag.; "stem filiform, subterete, branched on all sides; leaves lanceolate, acuminate, ribbed, without glands, spinuloso-dentate, waved and twisted; air-vessels spherical, somewhat margined, pointed, on filiform stalks shorter than themselves; receptacles two-edged or triquetrous, serrato-dentate, forked, their branches at length subpedicellate, agglomerated in the axil." *J. Ag. Sp. Alg. vol. 1. p. 326.*

HAB. On the Pacific coast of the Mexican Republic, *Leibman*. (v. s. in Herb. T.C.D.)

Stems or primary branches numerous, from a short stipe, a foot or more in length, filiform, slightly flexuous, smooth, closely set with short, alternate, spirally disposed, spreading branchlets. These branchlets in my specimen are an inch or two in length, the lowest not longer than the upper, and issue at intervals of half to three-quarters of an inch. *Leaves* an inch to an inch and half long, three or four lines in breadth, somewhat lanceolate, obtuse, thick, leathery, waved and curled, midribbed, almost destitute of glandular pores, sharply spinuloso-dentate, the teeth deltoid-acuminate, patent, with rounded sinuses between. *Air-vessels* few, and only on the uppermost branchlets, on very short stalks, spherical, with a narrow leafy border, and a small point or leafy mucro. *Receptacles* axillary, densely tufted, repeatedly forked, three-sided, sharply spinoso-dentate, much shorter than the subtending leaf. *Colour* dark brownish olive. *Substance* leathery, dense.

6. SARGASSUM *hystrix*, J. Ag.; "Stem filiform, subterete, branched on all sides;

* Page 53.

leaves oblong-elliptical, acuminate, ribbed, obsoletely glandular, serrate or sub-entire; air-vessels spherical, pointless, on very short stalks; receptacles warted, two-edged, twisted, spinous-toothed, forked, their branches at length pedicellate, crowded in the axils." *J. Ag. Sp. Alg. vol. 1, p. 322.*

HAB. In the Atlantic, from the shores of Mexico to those of Newfoundland. *J. Agardh.*

I am not acquainted with this species.

7. *SARGASSUM filipendula*, Ag; "stem filiform, very smooth; leaves narrow-linear, ribbed, with a single row of glands at each side the rib, serrated, the uppermost very narrow and nearly entire; air-vessels spherical, pointless, nearly without glands, on compressed stalks longer than themselves; receptacles cylindrical, warted, unarmed, paniculate on a long axillary ramulus, the lowermost stalked, the upper confluent." *J. Ag. Sp. Alg. vol. 1, p. 314.*

HAB. The Gulf of Mexico, *J. Agardh.*

Unknown to me.

II. PHYLLOSPORA. *Ag.*

Root branching. *Frond* distichous. *Branches* flat or compressed, fringed with marginal leaves. *Leaves* nerveless, undivided, tapering at base into sub-distinct petioles, marginal, distichous, vertical. *Air-vessels* formed by transformation of a portion of the leaf into a bladdery vesicle. *Receptacles* leaf-like, having numerous pores beneath which are placed the spherical conceptacles (or spore cavities). *Spore-cavities* declinous. *Spores* several in each conceptacle, to whose walls they are attached, obovoid, subsessile, having a hyaline perispore. *Antheridia* ellipsoidal, racemose. *Paranemata* long, simple, clothing the walls of the conceptacle.

A genus consisting of two species formerly placed in *Macrocystis*, of which they have in some respects the habit, but from which they essentially differ in fructification. The type of structure is in many respects lower than that of *Sargassum*; the fruit-leaves or receptacles scarcely differing from the ordinary leaves, except in being of somewhat smaller size, and thicker substance. The disposition of the branches and leaves is so unlike that of any other N. American Alga, that there

can be no difficulty in recognising our only species. Its congener (*Ph. comosa*) is a native of the shores of New Holland and New Zealand, and is distinguished by having serrated leaves.

1. *PHYLLOSPORA Menziesii*, Ag. ; stem flat, rough, especially below, with prominent points ; the margin at each side densely fringed with spathulate or obovate, obtuse, entire, nerveless leaves ; air-vessels large, ellipsoid, pyriform or spindle-shaped, tipped with a leafy crest. *J. Ag. Sp. Alg. vol. 1, p. 254. Harv. in Bot. Beechey Voy. p. 163. Kütz. Sp. Alg. p. 592. Phyllospora Chamissoi, J. Ag. l. c. Macrocyctis obtusa, Harv. in Bot. Beech. Voy. p. 163. Fucus Menziesii, Turn. Hist. t. 27. (TAB. III. FIG. B.)*

HAB. In deep water on the shores of California at Monterey (*Dr. Coulter, Capt. Beechey, and Capt. Wilkes*) ; and on the coasts to the northward as far, at least, as Nootka Sound, where it was first gathered by *Mr. Menzies* when sailing with Vancouver. (v. s. in Herb. T.C.D.)

Root branching. Stems (according to Turner, who cites Mr. Menzies' MS. notes) "twenty fathoms and more long, rising with a short rounded stipes, divided into several long simple branches, of almost equal height." These branches, portions of which, and the base of a young frond, are now before me, vary from a quarter inch to more than an inch in breadth, are strap-shaped, and roughened with minute spinelike or tubercular prominences, and preserve their breadth pretty evenly, except toward the tips, where they become gradually narrower, and pass off into a long slender point. The roughness varies considerably ; some specimens are densely erinaceous throughout ; others are so only in the lower part, with a few scattered spinular or subfoliaceous prominences above ; and others are quite smooth in the upper part. In all, the margins of the branch are set with distichous, vertical leaves, sometimes issuing at intervals of an inch apart, but much more frequently densely crowded, and forming a leafy fringe. They are of various sizes ; some reduced almost to bristles, and others being from two to three inches in length. The shape is also subject to great irregularity, the wide portion being sometimes three-fourths of an inch in width, in others scarcely two lines ; so that the leaf in some cases is narrowly spathulate, at others obovate : in all it tapers greatly to the base, and generally ends in a blunt point. The margin is more or less waved and curled, but destitute of any indentations. The *air-vessels* are formed by an inflation of the lower half, or imperfect petiole of the leaf, or else of a greater portion ; sometimes, therefore, they are tipped by a long leafy crest, at others by a short and narrow point. They vary much in shape ; being globose, ellipsoid, ovoid, pyriform, or spindle-shaped, and from half an inch to an inch and half in length. I have not seen fertile specimens.

AGARDH'S *P. Chamissoi* is said to be characterised by its *pyriform* air-vessels ; but on numerous specimens of the ordinary *P. Menziesii*, now before me, there are

scarcely two in which the vesicles are of the same size and shape. On a specimen from Mr. Menzies, they are very small and spindle-shaped; on Dr. Coulter's, some are globose and some ellipsoid and ovoid; and on Captain Beechey's, some are pyriform and others spindle-shaped, and of large size. The only valid reason for regarding *P. Chamissoi* as a species, is its habitat, should it really be, as is said, a native of the Atlantic.

In the Botany of Beechey's Voyage I distinguished a variety with leaves much broader than usual, under the name of *Macrocystis obtusa*, but I have long ceased to regard it as anything more than a form of *P. Menziesii*. At that time I had seen but few and imperfect specimens of this plant, and was not aware how greatly it varied in the shape and size of its leaves.

III.—HALIDRYS. *Lyngb.*

Root, a conical disc. *Fronde* much divided, distichous, pinnatifid below, pinnated above, without distinct leaves; and forming its air-vessels and receptacles from transformed portions of the upper branchlets. *Branches* alternate, the lowest flattish or somewhat leaf-like, the upper narrow, repeatedly compound and sub-filiform. *Air-vessels* petiolate, siliquæform, acuminate, articulated, divided by transverse septa into numerous loculi. *Receptacles* formed by transformation of the terminal ramuli, pedicellate, lanceolate or pod-like, tuberculated, unarmed, of a densely cellular substance; having numerous pores, beneath which are placed the spherical conceptacles (or spore-cavities). *Spore-cavities* containing both spores and antheridia in the same loculus. *Spores* numerous, oblong, sub-sessile, having a hyaline perispore. *Antheridia* on branching filaments, densely racemose. *Parane-mata* simple or forked, clothing the walls of the conceptacle.

The frond originates in an oblong, alternately-toothed root-leaf. As this increases in size, the marginal dentations lengthen out into lateral lobes, and the leaf becomes pinnatifid. Soon the uppermost lobes are found to elongate and become again pinnatifid. Some of the laciniae are afterwards changed into articulated air-vessels, and of course rendered abortive; others become branches, margined with similar air-vessels and ramuli; and the apex of the developing lacinia is eventually drawn out into a sub-filiform or compressed branch, which is repeatedly divided in a pinnate manner. The fruit is formed by a change of the ultimate divisions of the upper branches, and the receptacle, which is distinctly pedicellate, sometimes springs from the rachis of the branch, and sometimes crowns a vesicular ramulus or air-vessel.

The genus contains but two known species, both of which come within the limits of the North American flora, and one of them is peculiar to our shores. Both are

handsome shore-plants, and readily known by their articulated, many-celled air-vessels.

1. *HALIDRYS siliquosa*, Lyngb., frond compressed, narrow, repeatedly pinnate; air-vessels compressed, oblong or linear-lanceolate, mucronate, slightly constricted at the septa; receptacles lanceolate. *J. Ag. Sp. Alg.*, vol. 1, p. 236; *Kütz. Sp. Alg.*, p. 604; *Grev. Alg. Brit. t. 1.*; *Harv. Phyc. Brit. t. 66*; *Cystoseira siliquosa*, *Ag. Syst.*, p. 287; *Fucus siliquosus*, *L.*—*Turn. Hist. Fuc. t. 159.*; *E. Bot. t. 474.*

HABITAT. On rocks near low-water mark. Shores of Newfoundland, *Herb. Banks (fide Turner).* (v. v.)

Fronds from one to four feet long or more, linear, compressed, two edged, from one to two lines broad, distichous, repeatedly pinnate. *Pinnæ* alternate, the lower ones much lengthened, and either naked below or furnished with a few small branchlets and air-vessels, pinnate or bi-tripinnate above, each successive division becoming narrower. *Air-vessels* linear-oblong, or lanceolate, supported on slender stalks, and tipped by a slender acumination of various lengths, which sometimes ends in a receptacle. The air-vessels are internally divided by transverse membranes into numerous compartments or chambers, and externally marked at each partition by slight constrictions, most visible after the plant has been dried. *Receptacles* usually forming racemes, which terminate the branches, pedicellate, lanceolate, compressed. *Colour*, when young a greenish olive; becoming a rich, glossy brown in age. *Substance* tough and leathery.

This plant is very common on the Atlantic shores of Europe, and is said, by Turner, to extend south as far as the Canary Islands. On the same authority we claim it as a native of Newfoundland, but I have never seen any American specimens. The above description is taken from British ones.

2. *HALIDRYS osmundacea*, Harv. frond simply pinnatifid below, with broadly linear, subacute midribbed laciniae; decompound above, the pinnæ and pinnulæ slender, sub-filiform; air-vessels moniliform, deeply constricted at the septa; receptacles small, forked, crowning the air vessels. *Harv. in Bot. Beechey's Voy.*, p. 407. *J. Ag. Sp. Alg.*, vol. 1, p. 237. *Kütz. Sp. Alg.*, p. 604. *Cystoseira osmundacea*, *Ag. Syst.*, p. 287. *Fucus osmundaceus*, *Menz. in Turn. Hist. Fuc. t. 105.* (TAB. II.)

HAB. Rocks near low-water mark. At Port Trinidad, on the N. W. coast, *Archibald Menzies, Esq.* California, *Mr. D. Douglas.* Monterey, *Dr. Coulter*, (v. s. in *Herb. T.C.D.*)

Root discoid. *Frond* of unknown length, but probably many feet long when

when full grown. It originates in a pinnatifid, midribbed, flat leaf, six or eight inches in length, whose lowest laciniae are short and deltoid; the upper gradually longer, broadly linear, from three lines to half an inch in breadth, and from one to three inches in length. As the plant grows older, the midrib of the first leaf becomes slightly bordered with a thick lamina, and thus forming a two-edged stem, is developed upwards; and new laciniae, which are successively more compound as they are more distant from the root, are formed along it. The lowest of these divided laciniae are simply pinnatifid; the next more deeply cut, and their laciniae changed into vesicles. Those next in order are longer, more slender and more compound; and finally the upper branches of the fronds are slender and filiform, from one to two feet in length, and twice or thrice pinnate. The *air-vessels* begin to be formed on the first divided laciniae of the young plant, and are produced in great abundance on all the upper branches, sometimes every ramulus, and always several of those nearest the base of the branch being changed into air-cells. On old plants, when the upper branches have reached their excessively divided condition, the apices of the air-vessels frequently are extended into ramuli, which become again branched, and even develop small air-vessels along their branches. The *receptacles* are of small size, short, thickish, simple or forked, tuberculated, and spring from the tips of the uppermost air-cells on fully developed plants. The colour when dry is a dark rich brown, and the substance is thick and leathery.

Turner's figure is taken from a young, undeveloped specimen. In our plate we have shown the appearance of a young stem, and the base of an older one, which would have extended nearly thrice as high as the portion admitted into the figure; the upper secondary branches becoming longer and more compound. Some of these upper branches are indeed so much divided, that, apart from their bases, they may be mistaken for parts of a *Cystoseira*, and have much resemblance to *C. expansa*, but are more robust.

IV. CYSTOSEIRA. Ag.

Root a conical disc. *Fronde* much divided, either in a pinnate or dichotomous manner, the upper branches and ramuli filiform; forming receptacles by transformations of the ultimate ramuli, and air-vessels by swellings of the branches or ramuli. *Branches* alternate, naked or clothed with spine-like ramuli (or leaves). *Air-vessels* usually several together, forming a moniliform chain in some part of the branch. *Receptacles* formed by the transformation of the terminal ramuli, terete, tuberculated, smooth or thorny, of a densely cellular substance; having numerous pores, beneath which are placed the spherical conceptacles (or spore-cavities). *Spore-cavities* containing both spores and antheridia in the same loculus. *Spores* numerous, oblong or obovoid, sessile, having a hyaline perispore. *Antheridia* on branching filaments, racemose. *Paranemata* simple, clothing the walls of the conceptacle.

Nearly related to the preceding genus, from which it differs in the air-vessels, which do not here run together into a compound vessel of many cells, though they form little chains, one inflation of the branches succeeding another but remaining separate. Upwards of twenty species are described, of which thirteen or fourteen are found in the Mediterranean, and four occur on the Atlantic shores of Europe as far north as Great Britain, reaching their highest latitude on the western coast of Ireland. The group is scarcely represented in the New World. One or two of the European species are stated, on doubtful authority, to occur on the shores of Guiana and Brazil, where probably something else has been mistaken for them; but there is no record of any having been detected on the eastern shores of America, where European forms might, more naturally, have been anticipated. The only North American species with which I am acquainted is the following from California.

1. *CYSTOSEIRA expansa*, Ag.; frond (its base unknown) very long, filiform, slender, smooth, repeatedly pinnate, distichous, the ultimate ramuli simple or forked; air-vessels ellipsoidal, chained, several together in the lower half of the penultimate and ultimate branchlets; receptacles "cylindrical, warted, paniculate, subconfluent with the tops of the branches." *J. Ag. Sp. Alg.*, vol. 1, p. 226. *Cystoseira Douglasii*, Harv. in *Bot. Beechey*, p. 407. *Sirophysalis Douglasii*, and *S. expansa*, Kütz. *Sp. Alg.*, p. 603. (TAB. I. B.)

HAB. Probably in deep water. At Monterey, California, Mr. Douglas; Dr. Coulter. (v. s. in Herb. T.C.D.)

The root and lower part of the stem are unknown. Our specimens consist of portions of stems (or branches) from two to three feet in length, and about half a line in breadth, compressed, becoming narrower and more filiform toward the extremities; and thrice or four times divided in an alternately pinnate manner. The ultimate ramuli show a disposition to become dichotomous. *Air-vessels* from one to two lines long, ellipsoidal, in strings of four to eight, forming swellings in the smaller branches and ramuli; the string of swellings generally commencing near the base of the ramulus, and extending at least through its lower half. In the ultimate and smaller divisions the inflations are proportionally fewer and are sometimes solitary. I have not seen the receptacles which J. Agardh describes as being "6—8 lines long, everywhere of equal thickness, warted, and nearly all pedicellate."

This is probably a species of very great length, the portions of branches which are alone known to us being evidently only the upper divisions. There is a striking resemblance in habit between these and the most branching forms of *Halidrys osmundacea*, but in the present species each vesicle stands perfectly apart from its neighbour, however closely they may approximate.

DOUBTFUL SPECIES.

2. *CYTOSEIRA* (*Phyllacantha*) *oligacantha*, Kütz. "Of large size ; branches filiform, bipinnate, slender ; pinnæ very patent, alternate, sometimes opposite ; pinnules erecto-patent, sparingly spinous ; air-vessels chained, elliptic oblong ; receptacles nodoso-tuberculate, cuspidate." Kütz. *Sp. Alg.* p. 596.

HAB. Newfoundland, *Lenormand* (*fide Kützing*).

Possibly this may be a form of *C. fibrosa* ; but without seeing specimens it would be rash to decide.

V. FUCUS. *L.* (*in part.*) *Grev.*

Root a conical disc. *Frond* linear, compressed or flat, in the latter case traversed by a midrib, dichotomous, rarely pinnated : forming receptacles by transformations of the tips of the branches ; and vesicles (when present) by inflations in the substance of the stem or branch. *Branches* mostly fastigate, in some species winged with lamina, in none having separate leaves. *Air-vessels* often absent, simple, innate in the branches. *Receptacles* terminal or lateral, oblong or ovate, filled with mucus through which a net-work of jointed filaments extends ; having numerous pores beneath which are placed the spherical conceptacles (or spore cavities). *Spore-cavities* generally declinous, monœcious or mostly diœcious. *Spores* from two to eight in the same hyaline perispore, several such perispores rising from the walls of the cavity. *Antheridia* on branching filaments, ovoid, racemose or tufted. *Paranemata* simple, lining the cell.

A genus of *social* plants occupying the space between tide-marks, and contributing, on the shores where they grow, fully three-fourths of the vegetable clothing of the tidal rocks. Almost all the species are natives of the Northern Hemisphere, and chiefly of the Atlantic basin, where there are seven species on the European and five on the American shore ; one of the latter being peculiar to America, and two of the former to Europe ; the rest common to both. One species, allied to *F. nodosus*, is found at the Cape of Good Hope.

As already noticed in our Introduction, (p. 36), these common shore-plants yield, on incineration, a considerable per centage of carbonate of soda, to obtain which salt they were formerly largely collected and burnt. Iodine and mannite are also among their secretions.

By J. Agardh, in his recent work, this genus is divided into two, *Fucodium* and *Fucus*, the first of which, excluding some species, is identical with our first section.

Sect. 1. FUCODIUM, J. Ag. *Fronde compressed or subterete, without a midrib.*

1. *Fucus fastigiatus*, J. Ag. ; frond terete below, compressed above, linear, very narrow, many times dichotomous, fastigate ; the angles rounded and branches widely spreading ; air-vessels none ; receptacles terminal, simple or forked, oblong. *J. Ag. Sp. Alg. vol. 1, Sp. 203. Kütz. Sp. Alg. p. 591. Fucus furcatus, Harv. in Bot. Beechey, p. 163 (not of Ag.) (TAB. III. A.)*

HAB. On rocks within tide marks (probably above half tide level). Monterey, Douglas! Coulter! St. Francisco, Capt. Wilkes! (v. s. in Herb. T.C.D.)

Root a conical disc. *Fronde* rising with a short terete stem, which becomes forked at about half an inch from the base. The two primary divisions are generally much divaricated, making a very wide angle, and the frond is repeatedly forked at intervals of from half an inch to an inch, till it attains the length of six or eight inches. There are frequently as many as twelve furcations in plants of this size. The lower parts of the stem are from one to two lines in diameter ; the upper are gradually more and more slender, and at length the extreme forkings are often not a quarter line in breadth. The branches spread widely, so that the general outline of a frond is much broader than its length. There are no air-vessels. The branches are of nearly equal height, and in full grown specimens their tips are almost all enlarged into oblong or fusiform, simple or forked, tuberculated receptacles. *Spores* two in each perispore, a great number of which are attached to the walls of the spore-cavity.

My description and figure are made from Dr. Coulter's specimens ; those brought by Douglas and Wilkes (that I have seen) being of smaller size, and apparently gathered in shallower water. This species is, in many respects, allied to the European *F. canaliculatus*, and probably occupies similar ground, near high-water mark. My specimen from Douglas has altogether the dwarfed appearance which indicates such a locality.

2. *Fucus nodosus*, Linn. ; frond compressed, coriaceous, subdichotomous ; the branches linear, somewhat pinnated, attenuated at the base, remotely toothed, here and there swelling into oblong air-vessels ; receptacles lateral, globose, stalked, springing from the axis of the marginal teeth. *J. Ag. Sp. Alg. vol. 1, p. 206. Har. Phyc. Brit. t. 158. E. Bot. t. 570. Turn. Hist. t. 91. Ozothallia vulgaris, Dne.—Kütz. Sp. Alg. p. 591. Physocaulon nodosum, Kütz. Phyc. Gen. p. 352.*

HAB. On submarine rocks, between tide-marks. Abundant on the Atlantic shores of North America from Halifax to New York. Newfoundland, *De la Pylaie*. (v. v.)

*Fronde*s densely tufted, from one to three or four feet long or more, compressed, linear, much branched, more or less pinnate ; the branches long and subsimple,

tapering to the base and here and there toothed, secondary branches and receptacles springing from the axil of the tooth. *Air-vessels* elliptical, from half an inch to two inches in length, occurring at irregular intervals in the substance of the stem or branches, and much wider than the parts around them. *Receptacles* lateral, pedicellate, ovate or globose, yellow when ripe. *Spores* four in each perispore. *Colour* varying from a greenish to a fulvous olive. *Substance* tough and leathery.

This species varies much in size, and in the comparative robustness of the branches. When growing on the open sea shore, far removed from the influence of fresh water, it attains the length of several feet, and a breadth of nearly half an inch, the colour being of a dark bottle green. In deep bays or arms of the sea, it is much less luxuriant, and more tawny. When growing in æstuaries it becomes of still smaller and feebler growth. I am indebted to Mr. Nicholas Pike of New York for specimens gathered in Chelsea River, Boston Bay, in which the whole frond, though bipinnate and in fruit, is not more than six inches long, and scarcely a line in diameter at the widest part. These specimens are without air-vessels, but have all the other characters of the species.

Another singular form, the *Fucus scorpioides* of Flora Danica, t. 1479, has been sent to me by Mr. Hooper from Fort Hamilton, New York Bay. This is nearly as slender as that just mentioned, but is much more irregularly branched, having a tendency to dichotomous division, with many irregularly placed, divaricating lateral branches. I have compared it with a Norwegian specimen of *F. scorpioides*, with which it agrees very nearly. I was at first disposed to consider it identical with the *F. Mackaii* of British authors, but it is less regular in its branching than that (supposed) species. Both are regarded by J. Agardh, and perhaps justly, as varieties of *F. nodosus*.

Sect. 2. FUCUS, J. Ag. *Frond flat, with a midrib.*

3. *Fucus distichus*, Linn. ; stipes filiform, expanding into a very narrow, linear, dichotomous ribbed frond ; the margin very entire ; air-vessels none ; receptacles terminal, subsimple, in pairs, elongate-linear, compressed. *J. Ag. Sp. Alg. vol. 1, p. 209.* *Kütz. Sp. Alg. p. 590.* *Turn. Hist. t. 4.* *Fl. Dan. t. 351.* *Lyngb. Hyd. Dan. t. 1.*

HAB. Rocks between tide-marks. Shores of Greenland and Newfoundland, *De la Pylaie.*

Frond 3—6 inches long, rising from a filiform stipe, which gradually expands into an obsoletely ribbed, thickish lamina about a line in breadth and repeatedly forked. Axils acute. *Receptacles* scarcely wider than the segments which they terminate, linear, tapering to each end, from half an inch to an inch in length. *J. Ag. l. c.*

I am not acquainted with this species.

4. *Fucus furcatus*, Ag. ; stipes compressed, expanding into a linear, dichotomous, ribbed frond ; the margin very entire ; air-vessels none ; receptacles elongate, linear, flattish, repeatedly forked. *J. Ag. Sp. Alg. vol. 1, p. 209. Ag. Ic. Ined. t. 14. Kütz. Sp. Alg. p. 591.*

HAB. Newfoundland, *De la Pylaie*.

Frond a foot or more in length, and nearly four lines wide, with a less evident midrib than allied species, and which is altogether obsolete below the receptacle, dichotomous and fastigate. *Vesicles* none. *Receptacles* three inches long, scarcely thicker than the frond and nearly flat, linear, tapering towards the apices, obtuse, rarely simple, generally once or twice forked. *J. Ag. l. c.*

I am unacquainted with this species.

5. *Fucus ceranoides*, Linn. ; frond plane, coriaceo-membranaceous, linear, dichotomous, midribbed, without vesicles ; the margin very entire ; lateral branches narrower than the principal divisions, repeatedly forked, level-topped, bearing fruit at their apices ; receptacles spindle-shaped or bifid, acute. *J. Ag. Sp. Alg. vol. 1, p. 209. Kütz. Sp. Alg. p. 591. Turn. Hist. t. 89. E. Bot. t. 2115. Harv. Phyc. Brit. t. 271.*

HAB. On rocks and stones between tide-marks, chiefly where fresh water mixes with the sea. Rare on the American coast. New York, *J. Agardh. (v. v.)*

Frond resembling *F. vesiculosus* in aspect, but of thinner and more transparent substance, destitute of air-vessels, though portions of the frond occasionally puff out into irregular distensions ; and having numerous lateral, many-forked, narrow segments, whose tips are at length transformed into fruit. *Receptacles* commonly in pairs, sometimes confluent, bright yellow, or greenish, pointed.

I have not seen any American specimen of this species, which has been sent to Professor Agardh from New York.

6. *Fucus Harveyanus*, Dne. ined. (*cum Icone eximia*).

HAB. Monterey, California, *Herb. Paris*, (v. s. in Herb. T.C.D.)

I forbear to describe this species, named and figured by my friend M. Decaisne, some years ago, but of which no specific character has, I believe, yet appeared. It is very closely related to *F. ceranoides*, and I am not certain by what characters it is proposed to be distinguished from that species.

7. *Fucus vesiculosus*, Linn., frond flat, leathery, thick, linear, dichotomous, quite entire at the margin, midribbed; air-vessels globose or elliptical, mostly in pairs, (often absent); receptacles terminal, turgid, ellipsoid, ovoid, or spindle-shaped. *J. Ag. Sp. Alg.*, vol. 1, p. 210. *Kütz. Sp. Alg.* p. 589. *Turn. Hist.* t. 88. *E. Bot.* t. 1066. *Harv. Phyc. Brit.* t. 204. *Fucus divaricatus*, *F. inflatus*, *F. spiralis*, *F. volubilis*, *F. Sherardi*, *Auct. F. bicornis*, and *F. microphyllus*, *De la Pylaie*, &c.

HAB. On rocks and stones between tide-marks. Very common on all rocky shores from Greenland to New York. Also on the N. W. coast; in California, and northward. (The southern limit on the east coast not ascertained.) (v. v.)

Fronds from two inches to two feet long, or more; varying from a line to nearly an inch in breadth, flat, midribbed, many times forked; often spirally twisted. *Air-vessels* generally in pairs, one at each side of the midrib, spherical or oval, their size varying with the breadth of the frond. *Receptacles* very turgid, and filled with a lax, watery jelly, through which a network of delicate filaments extends. *Colour* olive or brown. *Substance* coarse and thick.

Very variable in size and degree of ramification, according to the locality in which it grows. When destitute of air-vessels, it may be mistaken by the student for *F. ceranoides*, but the frond is much thicker and more opaque than in that species, and contains a far greater proportion of alkaline matter. The earlier writers on marine plants made a great number of species out of this; but its varieties only appear different when isolated specimens are examined in the cabinet. On the sea shore all the various forms may be seen passing into one another at different tidal levels. *F. vesiculosus* is distributed in the northern Atlantic from the Arctic coasts to the Canary Islands; and in the Pacific, from Kamtschatka to California. It is reported to have been brought from the Cape of Good Hope and from Australia, but these localities want confirmation. On the east coast of America it and *F. nodosus* constitute at least three fourths of the covering of tidal rocks.

VI.—HIMANTHALIA. *Lyngb.*

Root a disc. *Frond* at first top-shaped, then cup-shaped, vesicular, unbranched. *Receptacles* very long, strap-shaped, repeatedly forked, springing from the centre of the cup-shaped frond, filled with mucus, traversed by jointed fibres, and pierced by numerous pores, beneath which are placed the spherical conceptacles (or spore-cavities). *Spore cavities* diclinous. *Spores* four within the same hyaline perispore, several perispores attached to the walls of the cavity. *Antheridia* on branching filaments, racemose. *Paranemata* simple, lining the cavity.

A remarkable plant, common on the coasts of Northern Europe, where, in England, it has the popular name "Sea-thongs," which is nearly a literal translation of the sounding Greek imposed by Lyngbye. The view here taken of the frond and receptacles is that first given by Greville and Wahlenberg, and more recently adopted by Agardh; and I have no doubt but that it is the correct view. Dr. Greville has well observed that the pezizæ-form or cup-shaped base, here called the *frond*, attains its full size before any portion of the strap-shaped branches containing fruit, and here called *receptacle*, makes its appearance. The branching receptacle then grows with rapidity, and after it has ripened spores, falls away. The plant is biennial, and, like all biennials, the first year is wholly occupied with the formation of the top-shaped *frond*; the receptacle is rapidly produced in the second season. Late in the autumn, when the old ripe receptacles are thrown off and drifted ashore in large banks, the young fronds for the next season may be seen sprouting in myriads round the dying ones of the last year. Carmichael says that the old fronds sprout again the second season, but I have never observed them do so, though I have repeatedly sought for such second growth.

1. *HIMANTHALIA lorea*, Lyngb.; frond top-shaped, at length collapsing, plano-convex, stipitate; receptacles repeatedly dichotomous, linear, tapering to the extremity. *J. Ag. Sp. Alg.*, vol. 1, p. 196. *Harv. Phyc. Brit.* t. 78. *Fucus loreus*, *Turn. Hist.* t. 196. *E. Bot.* t. 569. *Fl. Dan.* t. 710.

HAB. Rocks near low-water mark. Biennial. "Coast of North America," *fide J. Agardh.* (v. v.)

Fronds an inch in height, top-shaped, the centre of the disc becoming depressed, and at maturity throwing out a strap-shaped receptacle from two to ten or even twenty feet in length, from a quarter to half an inch in width, tapering to the apices, and many times forked. *Receptacles* scattered in myriads through the whole length of this gigantic receptacle.

I have seen no American specimen of this plant, and am not aware on what part of the shore it has been gathered, or by whom communicated to Professor Agardh. Judging from probabilities, I should suppose that it may have been found at Newfoundland, or to the north of that island. It is much more abundant in Europe, on the northern coasts, though said to extend southward as far as Spain.

ORDER II.—SPOROCHNACEÆ.

Harv. Man. Br. Alg. Ed. 2, p. 21. Sporochnoideæ, Grev. Alg. Brit. p. 36. J. Ag. Sp. Alg. vol. 1, p. 160. Kütz. Phyc. Gen. p. 342. Kütz. Sp. Alg. p. 567. Endl. 3rd. Suppl. p. 28. Chordarieæ, in part Ag. Syst. p. xxxvi. Sporochnideæ and part of Dictyotidæ, Lindl. Veg. Kingd. p. 22.

DIAGNOSIS. Olive-coloured, inarticulate seaweeds, whose spores are attached to external, jointed filaments, which are either free or compacted together into knob-like masses. (*Plants of mediocre size, soon becoming flaccid in the air, and then changing to a verdigris-green colour*).

NATURAL CHARACTER. *Root* usually a small, naked disc or point of attachment; in *Carpomitra*, bulbous and coated with woolly threads. *Fronds* of mediocre size, and much branched, frequently bushy, having, whilst living, a clear and rather bright brownish olive or chestnut colour, and a cartilaginous, firm, crisp substance; but rapidly becoming flaccid and changing to a verdigris green colour on exposure to the air, and possessing, after this change, the faculty of rapidly decomposing any small *Algæ* with which they may come in contact. *Stems* and *branches* uniform, destitute of any separate, leaf-like expansions, inarticulate; sometimes cylindrical and filiform, often exceedingly slender; sometimes compressed; and sometimes flattened, leaf-like, and furnished with a distinct midrib, occasionally throwing off lateral nervelets. The branching is frequently opposite, and almost always distichous. *Air-vessels* none. Almost all bear, at some period of their growth, pencils of delicate, jointed, confervoid filaments. In some, as in *Desmarestia* and *Arthrocladia*, these filaments are found on the growing apices, and on all the younger portions of the frond, and appear to be intimately connected with the process of cell-division then going on; and they gradually fall away after the part has attained its full size. In *Arthrocladia* a portion of them remains, and eventually supports the fructification. In others, as in *Sporochnus* and *Carpomitra*, similar filaments spring from and crown the receptacles of the fructification, and fall away when the spores have arrived at maturity.

The outward appearance of the fructification varies in the different genera of this Order, but the differences are of a minor character. In all, the spores are attached to branching, articulated filaments which issue from some part of the branches, and are, therefore, external to the substance. But in some, as in all the American genera, these filaments are free, either clothing the branches or forming pencil-like

tufts along them ; while, in others (*Sporochnus* and *Carpomitra*) the fertile filaments are closely packed together and combined into knob-like receptacles, in whose substance the spores are hidden. On dissection these receptacles are seen to be made up of branching filaments, of some of whose branches the spores are formed ; and they are either borne on minute, lateral ramuli (or peduncles), or terminate the larger branches of the frond.

A small group of plants, of which five or six genera, comprising about 24 species, are at present known to botanists. They are all plants of deep water, none growing in places where they are left dry at the recess of the tide, and very few being found much above low-water mark, and then only in deep and shady tide-pools. They increase in numbers and in luxuriance of development at three or four fathoms depth, and extend to fifteen or twenty fathoms, often constituting at the bottom of the sea submarine fields of considerable extent. This is the case on the North American coast with respect to *Desmarestia aculeata*, which, in deep enclosed bays, like that of Halifax, is often the only plant that comes up in the dredge after five fathoms of depth, and in many places it seems to choke all other vegetation. A similar prevalence of two other species of this genus (*D. chordalis* and *D. Rossii*) in the deeper parts of the Laminarian zone, has been noticed by Dr. Hooker in the Antarctic Ocean.

Several of the plants of this Order are widely distributed. All the American species of *Desmarestia* have a range almost as wide as that of the ocean ; being found in the temperate and colder regions at both sides of the torrid zone, and extending almost to the limit of marine vegetation towards either pole. Their reputed absence in the tropical waters is perhaps owing to a failure of observation. *Arthrocladia villosa*, recently discovered in North Carolina, had been until then supposed to be confined to the shores of Europe, where it almost always accompanies *Sporochnus pedunculatus*, a species not yet added to the American Flora. The genus *Chnoospora* is entirely tropical, but is found both in the eastern and the western hemisphere.

Although the different aspect of the fruit in this Order forces us to group the genera under two families, yet there is such a peculiar habit common to all the individuals of the group, that authors scarcely differ in the limits they assign to it. Agardh and Kützinger coincide with the original view of Greville, which is that here adopted ; but Endlicher and following him, Lindley, reject *Arthrocladia* and refer it to the neighbourhood of *Cutleria* in Dictyotaceæ. A comparison of the respective structure and development of *Arthrocladia* and *Desmarestia viridis* will I think show that these plants cannot well be far separated. There is something so distinctive in the colour of the Sporachnaceæ when fresh, and the very remarkable change which they undergo on exposure to the air, that these peculiarities alone seem to point, as Mr. Dawson Turner has long since noticed, to a natural affinity among them.

All the following genera belong to the sub-order ARTHROCLADIÆ.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

- I. ARTHROCLADIA. *Frond* pinnate, filiform, nodose, hollow ; the tube articulated within. *Nodes* whorled with delicate filaments.
- II. DESMARESTIA. *Frond* pinnate, either filiform, compressed, or flat, solid.
- III. CHNOOSPORA. *Frond* dichotomous, flat.

I. ARTHROCLADIA, *Duby.*

Frond cylindrical, pinnated, traversed by a wide, empty tube which is interrupted at short intervals by transverse, membranous septa that divide it into a number of vertically seriated air-cells. *Walls* of the frond composed of several rows of cells, arranged in longitudinal series, and diminishing in size from the central tube outwards. Externally the surface is marked at short intervals by nodose swellings, which are clothed with a whorl of numerous confervoid repeatedly pinnate articulated filaments. *Spores* formed from the cells of moniliform, podlike filaments borne along the inner faces of the lower divisions of the whorled filaments, oblate-spheroidal, minute.

A genus consisting of but one species, a native also of the shores of Europe, where it is found from Italy to Scotland, generally in deep water. It is a slender, filiform, distantly branched plant, delicately beautiful when its branches are young, and the pencils of filaments that whorl them uninjured.

1. ARTHROCLADIA *villosa*, *Duby.* *J. Ag. Sp. Alg.*, vol. 1, p. 162. *Kütz. Sp. Alg.*, p. 573 (*A. septentrionalis* and *A. australis*, *Kg.*) *Harv. Phyc. Brit.* t. 64. *Conferva villosa*, *Huds.*—*E. Bot.* t. 546. *Dillw. Conf. t.* 37. (PLATE IV. A.)

HAB. On submarine substances, in five (or more?) fathoms ; very rare. Cast ashore at Smithville, near Wilmington, N. C., *Mr. Charles Congdon.* (v. v.)

Root a small disc. *Fronds* generally tufted, from six inches to nearly three feet in length, very slender, once, twice, or thrice pinnated, filiform ; the pinnæ distant, opposite, or rarely alternate, patent, simple or again pinnulated with similar, simple pinnules ; all the divisions furnished at intervals of from half a line to a line, with minute knoblike swellings which produce whorls of very delicate, byssoid, repeatedly pinnate jointed filaments of a pale green colour. The frond is traversed by a wide tube, divided by transverse membranes at short intervals into joints or chambers, four or five of which intervene between every whorl of filaments. This tube is surrounded by several series of cylindrical cells, placed end to end

vertically, the innermost of which are of largest size, and the cells of each row to the circumference of less and less dimensions. The substance of the frond when quite fresh is cartilaginous, but it soon becomes flaccid in the air; and the colour, which at first is a bright bay, rapidly changes to verdigris green. The *fructification* is borne on the lowermost divisions of the whorled filaments, and forms moniliform strings of spores springing from the inner faces of the branch. These are developed by the metamorphosis of secund ramuli, and consist of a large number of very minute, oblate spores, which fall asunder when mature. In drying, the plant adheres firmly to paper.

I am indebted to Mr. Congdon for one of the few specimens of this rare plant, which he succeeded in saving during a very hasty visit to the shore near the mouth of the Cape Fear River. It is roughly dried, and I have, therefore, been obliged to use more carefully preserved (British) specimens to give an idea of the natural appearance of the species (*at Pl. IV. fig. A 1.*), but I have drawn the magnified figures (2, 3, 4, 5, 6) from Mr. Congdon's specimen, so that there can be no doubt of their identity. The description of the species given above is mostly copied from the *Phycologia Britannica*. The magnified figures in Pl. 64 of that work, especially figs. 2 and 4, are much less correct than the corresponding one (2 and 5) now given.

II. DESMARESTIA, *Lamouroux*.

Frond linear, either cylindrical, compressed or flat, pinnated, solid, traversed by a slender articulated filament (or axis); the solid parts composed of several rows of small cells. *Branches* when young producing along the margin, and from the tips, tufts of byssoid, articulated, repeatedly pinnate filaments. *Fructification* unknown.

This genus, of which the fruit is at present unknown, is readily distinguished from *Arthrocladia*, by the structure of the frond. Here there are not the knots along the stem and branches, whorled with delicate filaments, which mark that genus; and moreover the frond, in the present group, is destitute of a tubular axis of large calibre. It is true that the articulated filament which traverses the stem and branches in *Desmarestia* may be compared with the articulated tube of *Arthrocladia*, but the former consists of a string of single cells, placed end to end; the latter is a compound structure, whose walls and septa are both made up of a great number of cells.

The manner in which the frond is developed may be readily seen by examining, under the microscope, any tip of a young branch in process of formation; particularly in the young points of *D. viridis* and *D. ligulata*, in which species the frond is more transparent than in *D. aculeata*. In *D. viridis* the young branch is prolonged, at its apex, into a confervoid filament, formed of a row of cylindrical

cells, lengthening by division of the terminal cell, and becoming branched at intervals by the development of opposite budding cells from the shoulders of the older ones. Thus we have in its simplest form the type of the growth of the species; namely, a repeatedly pinnate division, with opposite pinnules. These pinnated confervoid apices become gradually clothed with a stratum of minute cellules, which may be observed commencing to be formed on the lowermost cells (those nearest the compound portion of the branch), and gradually extending upwards. Thus at length the confervoid filament is completely enclosed in a cellular coating; new coats are continually added to this;—until the frond becomes a cylindrical, compound-cellular body, through the centre of which runs an articulated filament; which filament was the earliest part formed, and the axial nucleus round which the other parts grew.

The manner of growth in *D. ligulata* is precisely similar, except that in that species the new cellular integument to the primary filament is not developed equally on all sides, but extends chiefly laterally, so as to form at first a two-edged and then a flat or even leaf-like stem. In this process of lateral extension, or widening of the stem, the lower portions of the pinnæ of the primary filament being enclosed within the cellular wings of the flattened branch, become the lateral nerves of the frond. Some of these merely reach the margin of the flat stem, or extend slightly beyond it, as a tooth, tipped with a pencil of fibres; others, continuing to vegetate, become the nuclei of the young lateral branches. In the broad forms of *D. ligulata*, constituting *D. herbacea* of authors, the nervation and its origin are both very clearly seen.

1. *DESMARESTIA viridis*, Lamour. frond cylindrical, filiform, repeatedly pinnate; pinnæ and pinnulæ capillary, exactly opposite, patent. *Kütz. Sp. Alg. p. 570. Harv. Phyc. Brit. t. 312. Dichloria viridis*, Grev. *Alg. Brit. t. 6. J. Ag. Sp. Alg. vol. 1, p. 164. Fucus viridis*, Fl. Dan. t. 886. *Turn. Hist. t. 97. E. Bot. t. 1669.*

HAB. On rocks, stones, and the larger Algæ in tide-pools, near low-water mark, and extending into deep water. Annual. Abundant on the shores of British America, and extending south to Boston Bay; Cape Anne, Connecticut; and Hell-gate, New York, *Mr. J. Hooper. Unalaschka, Chamisso. (v. v.)*

*Fronde*s from one to three feet in length, cylindrical, from a quarter line to half a line, or sometimes a line in diameter below, gradually attenuated upwards to a hairlike fineness, excessively branched, having an ovate outline when the branches are freely displayed. All the branches, and every one of the lesser divisions, down to the most minute ramulus, are exactly opposite and distichous; the larger divisions are patent, or nearly horizontal, the lesser more erect. In a vegetating state the branches and ramuli terminate in extremely slender, articulated, byssoid filaments, which gradually become coated with cellules; and then the imbedded filament becomes the axis of the compound frond. *Structure* densely cellular, with numerous large air-cavities dispersed through the cellular

substance. *Colour*, when growing, a fine chesnut-olive, quickly changing to verdigris green when removed from the water. *Substance* tender, soon decomposing.

2. *DESMARESTIA aculeata*, Lamour. ; stipes short, cylindrical ; stems (or primary branches) elongate, flattish, bi-tripinnate ; pinnæ and pinnulæ alternate, very narrow, tapering to the base, either fringed with opposite tufts of bright green filaments or margined with awl-shaped, alternate spines. *J. Ag. Sp. Alg. vol. 1, p. 167. Kütz. Sp. Alg. p. 571. Harv. Phyc. Brit. t. 49. Grev. Alg. Brit. t. 5, f. 2, 3. Fucus aculeatus, Linn. Turn. Hist. Fuc. t. 187. Eng. Bot. t. 2445. (TAB. IV. B.)*

HAB. On submerged rocks and stones at low-water mark and at a greater depth. Very abundant on the east shores, from our northern limits to Long Island Sound (at least). Probably also on the N.W. coast (being found at Kamtschatka). (v. v.)

Fronds from one to six feet in length, about half a line in width, compressed or flattish, excessively branched and bushy ; the branches usually alternate, rarely opposite, erect, tapering to their base and apex, as do also all the lesser divisions. When young the branches are of a tender substance, soft to the touch, and clothed at intervals of about a line with opposite pencils of finely divided byssoid filaments of a beautiful yellow green colour. In older fronds these delicate filaments fall away, and the branches become rigid and tough, while subulate spinelike alternate teeth are developed from the margin at every three or four lines apart. In transition specimens both spines and filaments are found together, the former being comparatively soft. *Colour* pale olive when young, foxy brown or sometimes very dark when old.

At different ages this plant may readily be taken by a student for two species, as indeed it was by Linnaeus himself.

3. *DESMARESTIA ligulata*, Lamour. ; frond flat, with a slender, more or less evident midrib, repeatedly pinnate ; pinnæ and pinnulæ opposite, oblong or lanceolate, tapering to both ends. *J. Ag. Sp. Alg. vol. 1, p. 169. Kütz. Sp. Alg. p. 572. Harv. Phyc. Brit. t. 115. Fucus ligulatus, Turn. Hist. t. 98. E. Bot. t. 1636. Fucus herbaceus, Turn. Hist. t. 99. Desmarestia herbacea, Auct.*

HAB. North West Coast, *Mr. Menzies.* (v. v.)

The ordinary European form of this species, figured in *Phyc. Brit. t. 115*, has not yet been noticed on the American coast, except at Cape Horn (!), but may be expected to occur on the shores of some part of British America. The plant recorded above as having been found by Mr. Menzies on the N. W. coast has broader leaves, but, to judge by Mr. Turner's figure, is scarcely otherwise to be distinguished. The following is his description of Mr. Menzies' specimens :—

"*Fronde* flat, two feet or more long, rising with a single, undivided *stem*, at its base nearly cylindrical, and as thick as a crow's quill, but almost immediately becoming flat, and gradually widening to the height of a few inches, where it acquires a width of half an inch, or three quarters of an inch, after which it becomes linear, till, on approaching the extremity, it is again slightly narrowed and terminates in a rounded apex; the margins are throughout the whole length serrated with small, spiniform, rather remote teeth; the stem, from root to summit, is pinnate with opposite, distichous branches, of the same substance as itself, between horizontal and patent, separated by intervals of about half an inch, a foot or a foot and half long, and the middle ones, apparently, longest, their greatest width nearly an inch, attenuated at their bases into very short, subcylindrical petioli, rounded at their apices, toothed at their margins, and in their turns pinnated with a series of others, similar to them in every particular, except their small size:—throughout the whole frond runs a midrib, thick and rather wide in the stem, but in the branches thin and faint, so as scarcely to be visible, unless the plant is held to the light, and appearing only like a dark line. *Colour* grass-green, with a faint tinge of brown, transparent. *Substance* membranaceous, extremely thin and tender, but somewhat thickened in the stem, near the root."

I have not seen any American individuals of this variety, but have gathered an equally broad-leaved form at the Cape of Good Hope, having, however, acute pinnæ, and a firmer and more coriaceous substance than Turner describes. On the whole I agree with Prof. J. Agardh in uniting, as one species, the broad leaved and narrow leaved forms.

III. CHNOOSPORÆ, J. Ag.

Fronde compressed, repeatedly dichotomous, ribless; its substance composed of elongate prismatic cellules, scarcely denser in the centre. *Fructification*, densely tufted, clavato-moniliform, articulated, spore-bearing filaments, surrounded by sterile, branching filaments (*paranemata*), both aggregated together in wartlike excrescences near the middle of the frond. *Spores* (?) formed in the articulations of the sporiferous filaments, rounded.—(J. Ag.)

A small genus of tropical Algæ, readily known by its dichotomous branching. It seems to connect together, naturally, the two sub-orders of which the Order consists. In the structure of its masses of fructification there is an evident passage between those genera with dispersed spore-filaments and those in which these organs cohere together into definite receptacles.

1. CHNOOSPORÆ *fastigiata*, J. Ag.; "fronds tufted, several rising from the same

callus, erect, many times forked, fastigiate; segments compressed above, patent, with acute axils." *J. Ag. Sp. Alg. vol. 1, p. 171.* *Kütz. Sp. Alg. p. 569.* *Ch. Pacifica* and *Ch. Atlantica*, *J. Ag. Liebm. p. 7.* (Tab. IV. C.)

HAB. On the Pacific coast of the Mexican Republic, *Liebman.* (v. s. in Herb. T. C. D.)

Fronds many, from the same scutate base, 2-3 inches long, stipitate, soon forked, and then repeatedly divided dichotomously, the forks being closer and closer upwards; equal in diameter throughout, subcylindrical below, compressed above, with acute apices. The *axils* of the forks are narrow and acute. *Colour* in a dried state very dark, brownish. I have not seen perfect fructification.

I have not been able on the specimens which I have had an opportunity of examining, to make out the structure of the fructification with sufficient accuracy to authorize my introducing the cushions of spore-filaments into the plate. The above description is therefore chiefly translated from Prof. J. Agardh's account of the genus. In aspect the plant resembles a very narrow *Dictyota*, but its substance is very much thicker, and a section under the microscope shows it to be composed of a much greater number of rows of cells. The surface cellules are very minute, and the cells increase in length and breadth as they lie more towards the centre of the flesh.

ORDER III.—LAMINARIACEÆ.

Laminariæ, *Grev. Alg. Brit., p. 24.* *J. Ag. Symb. p. 4.* *Sp. Alg. p. 121.* *Endl. 3rd, Suppl. p. 26.* *Kütz. Phyc. Gen. p. 344, and part of Chordeæ, p. 333.* *Sp. Alg. p. 573.* *Laminaridæ*, *Lindl. Veg. Kingd. p. 22.*

DIAGNOSIS.—Olive-coloured, inarticulate seaweeds, whose spores are superficial, either forming indefinite, cloudlike patches, or covering the whole surface of the frond. (*Plants of large size, not much divided, usually stipitate, foliaceous.*)

NATURAL CHARACTER.—*Root* rarely a simple, undivided disc; commonly much branched, or only simple and disc-like when young. As the plant advances in growth, new accessory holdfasts are formed toward the base of the stipe round the primary one, and these, lengthening and branching, unite into a conical mass of rootlets (or cables), which together make up the compound root. *Fronds* of an olive-brown or an olive-green colour, mostly becoming darker on exposure to the air, in some cases turning green in drying; usually tough and leathery in substance,

but in some delicately membranaceous ; the internal structure fibroso-cellular, the flesh being chiefly composed of interlacing threads, formed of strings of cylindrical cells, placed end to end. The plants of this Order are almost all of large, frequently of gigantic size, either tubular or furnished with a *stipe* which expands at the summit into a leafy frond. In the least developed genus (*Adenocystis*) the frond consists of a hollow, membranous bag, contracted at the base into a little stalk, and gradually tapering to the apex into a simple point. At the next stage (*Chorda*) the form is still tubular, but the tube becomes cylindrical, or filiform, and is divided internally into several compartments, by transverse membranes stretched across its cavity. In the more perfect genera we clearly recognise a cylindrical solid stem or *stipe*, occasionally vesicular in its upper portion, and bearing at its summit an expanded leaf. This stem is in most cases simple ; in the most perfect genera alone it becomes branched, its divisions being repetitions of the primary idea. The leafy expansion crowning the stem or branches is sometimes ribbon-shaped, quite simple and tapering to its extremity ; sometimes it is cloven vertically into many narrow laciniae, by a process of natural splitting which takes place in a very irregular manner ; sometimes it is regularly pinnatifid (as in *Ecklonia*) and lastly (in *Agarum* and *Thalassiophyllum*) the whole expansion is perforated with holes, like a sieve. In the majority of cases the leaf is ribless ; but in the more fully organized a midrib, formed of a prolongation of the apex of the stipe, traverses its substance. *Air-vessels* are very often wanting ; where they are found, they are formed either by distensions of the upper portion of the stipe, or (in *Macrocystis*) by vesications of the petioles of the leaves.

In those species that are perennial the stipe lasts for several years, but the leaf is changed at the end of each season. The process for effecting a change of leaf is gradual, and commences long before the fall of the previous leaf. The new leaf is not formed, however, in the axil of the old one, but begins at the apex of the stipe, or in that portion where the stipe, or common petiole, passes into the leaf. At that point, new and vigorous tissue is always found ; there a new lamina begins to expand, and as it elongates it gradually pushes before it the older part of the leaf, which for a long time adheres to the apex of this new part, and falls away only when the new leaf has reached the normal size.

The fructification of this Order is on a very simple type of development. Innumerable minute *spores*, each contained within a hyaline perispore, are formed out of the surface cells either of the whole frond, or of some large and imperfectly defined portions of it. In the highest types only (as in *Alaria*) are spores found in spaces definitely limited, or in proper leaflets. In the lowest (*Chorda*) they clothe the whole surface, and in most other cases (*Laminaria*, *Agarum*, &c.) they form cloud-like, dark-coloured patches of considerable extent and uncertain limits. Usually but one spore is found in each perispore, but in some each perispore contains four sporules. Barren filaments, or *paranemata*, occasionally accompany the spores, and in some cases *Antheridia* are found attached to them. These last are oval cells, filled with minute corpuscles.

The *Laminariaceæ*, though formed on a much less fully organised type than the

Fucaceæ, are of much larger dimensions. The number of species under twelve inches in length is very small; almost all, when mature, exceed twelve feet in length, and when we light upon the real giants of the Order, the frond is measured by fathoms and not by feet. The ordinary *Oarweeds*, *Tangle*, *Devil's-apron* and *Sea-colander* of the American shores, which are familiar examples of these plants, are frequently seen ten, twelve, or even twenty feet in length, with immense fronds or aprons terminating their stems; but these are mediocre indeed, compared to some of their co-ordinals in the Pacific. The *Nereocystis* of the North West Coast is said, when fully grown, to have a stem measuring 300 feet in length, which bears at its summit a huge air-vessel, six or seven feet long, shaped like a great cask, and ending in a tuft of upwards of fifty forked leaves, each of which is from thirty to forty feet in length. The cask-like air-vessel buoys up this immense frond, which, like Milton's hero, lies

Prone on the flood, extended long and large,
(And) floating many a rood.—

Here the Sea Otter (*Lutra marina*) has his favourite lair, resting himself on the vesicle, or hiding among the leaves while he pursues his fishing. The stem which anchors this floating mass of fronds, though no thicker than whip-cord, must be of considerable strength and flexibility; and accordingly we find it employed as a fishing line by the rude natives of the coast. But great as is the length of this seaweed, it is exceeded by the *Macrocystis*, whose stems are calculated by Dr. Hooker* occasionally to reach 700 feet, while Bory St. Vincent attributes to them a length of 1500 feet. These are the longest fronded of the Order, and indeed the longest vegetables that are known. Others, as the *Lessoniæ* of the Pacific and Southern Oceans, though of less height have stems of much greater bole, and a habit that reminds us of some large endogenous arborescent plants, as the *Aloe dichotoma* or as the *Dracæna Draco*. These gigantic Algæ have trunks of considerable diameter and height, branched dichotomously, each branch bearing at its summit bunches of long ribbon-like leaves. Torn from the submerged rocks on which they grow, these marine trees are driven ashore on the rocky coasts of the Falkland Islands in great numbers, and lie, as Dr. Hooker well describes, rotting for many a mile, in banks several yards in breadth and three or four feet in depth. The trunks, from which the leaves have been washed, resemble drift-wood, and "on one occasion" (as related by Dr. Hooker) "no persuasion could prevent the captain of a brig from employing his boat's crew, during two bitterly cold days, in collecting this incombustible weed for fuel." Another noble genus of the Southern Ocean (*Ecklonia*) may be compared to the Palm in habit, having pinnated fronds of large size. One of the best known species, the *Trumpet-weed* (*Ecklonia buccinalis*) of the Cape of Good Hope, has a stem often more than twenty feet in height, crowned with a fan-shaped cluster of leaves, each twelve feet long or more. The stem of this seaweed which is hollow in the upper portion is, when dried, often used in the colony as a siphon; and by the native herdsmen is formed into a trumpet for collecting the cattle at evening. But perhaps the most curious plants of the Order

* Fl. Antarct. vol. 3, p. 464.

are the Arctic genera *Agarum* and *Thalassiophyllum*, both found within our limits and described below.

The Order contains some fifty species, about half of which are natives of the western world, and the largest portion of these of the northern continent. They are plants of deep water, rarely vegetating within tide-marks, or barely reaching a few inches above low water mark, and characterise a broad zone of depth extending from low water to four or five fathoms below it; while the larger species straggle into deeper water, to an unknown distance from the surface. Many of these probably first vegetate on detached masses of rock at a moderate depth, and are afterwards drifted, carrying their rocky anchors with them, into the deeper sea. They are mostly plants of high latitudes, to which the greater number are confined. *Macrocystis* and *Ecklonia* are characteristic of warmer climates, and extend, as well as some species of *Laminaria*, into the tropical zone.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

1. *Frond having a stem, furnished with definite leaves.*

- I. MACROCYSTIS. Stem filiform, branched. *Leaves* simple, secund along the stem, each leaf rising from a stalked air-vessel.
- II. NEREOCYSTIS. Stem filiform, unbranched, bearing at its summit an air-vessel, from which many forked leaves spring.
- III. LESSONIA. Stem dichotomous (or simple?). *Leaves* terminating the branches. *Air-vessels* none.

2. *Frond stipitate, the stipes expanding at the summit into a simple or cloven lamina.*

* *Lamina midribbed.*

- IV. ALARIA. *Lamina* traversed by a single rib.
- V. COSTARIA. *Lamina* traversed by several parallel ribs.

** *Lamina without midrib.*

- VI. LAMINARIA. *Lamina* either simple or cloven.

3. *Frond flat, pierced, like a colander, with holes.*

- VII. AGARUM. *Lamina* midribbed.
- VIII. THALASSIOPHYLLUM. *Lamina* without midrib, spirally developed round a (branching) stipe.

4. *Frond cylindrical, tubular or bag-shaped.*

- IX. CHORDA. *Frond* filiform, septate within.
-

1. MACROCYSTIS, Ag.

Root branching extensively. *Stem* filiform. *Leaves* simple, formed by the continual splitting of a primary terminal leaf; developed in second order along the lengthening stem, petiolate, having an *air-vessel* in the petiole. *Spores* forming irregular, superficial, cloudlike patches on small radical leaves, ellipsoidal, with hyaline perispore, surrounded by densely packed, inarticulate, clavate paranemata.

When fully grown the frond in this genus consists of a much branched root, from which rise many filiform, simple or branched stems, naked below; but furnished above with numerous, unilateral, lanceolate, petiolate leaves, having their petioles enlarged into pear-shaped or oblong air-cells. The lateral leaves have their edges directed toward the stem and are so far vertically disposed; and the stem itself, when unbroken, always terminates in an oblique leaf, broader than the rest, and having one or more slits in its base. This terminal leaf is the growing apex, and from the development of the slits in its base new lateral leaves are gradually separated. The whole frond, indeed, much divided as it eventually becomes, has been developed from the continual splitting of such a leaf. The young stem as it first rises from the root bears at its summit a single vertical leaf, destitute of vesicle, serrated, except at a short distance above the base, and having the apex generally a little hooked in: its outline is therefore somewhat scymetar-shaped. In this leaf, commencing within the margin of its lowest edge, are gradually formed a series of splits, proceeding from the base and extending upwards towards the apex. As each split increases in length, it widens by the onward growth of the common base; and air-vessels begin to be formed in the lower and slender part of the segments, which are gradually separated. The splitting process continues until the split reaches the margin, at which time the air-vessel is completely formed, and the margin of the young segment furnished with ciliæform teeth; and its apex being at length free, it becomes a leaf, only differing in size from those lower down on the stem, and which have had a similar origin.

The fructification is found only on root-leaves which never rise to the surface and are destitute of air-vessels. It forms cloudy patches, and contains myriads of extremely minute spores.

The student will find an interesting history of this genus, illustrated by an excellent figure showing the development of the leaves, in Dr. Hooker's *Flora Antarctica*, vol. 2, p. 461—466, tab. 169, 170, 171.

1. MACROCYSTIS *pyrifer*; Ag. Hook. and Harv. in Hook. *Fl. Antarct.* vol. 2, p. 461. *Macrocystis Humboldtii*, *planicaulis*, *angustifolia*, *tenuifolia*, *pyrifer*, *pelagica*, *luxurians*, *latifolia*, *Orbigniana*, Auct.—J. Ag. *Sp. Alg.* p. 155—158. Kütz. *Sp. Alg.* p. 582—583 (also *M. Dubenii*, Aresch., *latifrons*, Bory, &c.). *Lessonia ciliata*, Post. and Rupr. *Illust.* p. 9, t. 38, f. 9.

HAB. Shores of California, *Beechey*, *Coulter*, *Wilkes*, &c. Unalashka and Sitcha, *Postels* and *Ruprecht*. (v. v. ad C. B. S.)

Root much branched. *Stems* from five feet to several hundred feet long, filiform or flattish, eventually subdichotomously branched. *Leaves* lateral, secund along the branches, lanceolate, varying much in length and breadth, membranaceous or coriaceous, smooth or wrinkled, bordered with slender cilia or subulate teeth; each leaf rising from an air-vessel. *Air-vessels* as variable in form and size as the leaves, globose, ellipsoidal, pear-shaped or fusiform, or long and narrow-club-shaped.

I fully concur with my friend Dr. Hooker in the view of this species which we have jointly taken in another place. (*Fl. Ant. vol. 2, p. 461.*) We have together carefully examined specimens representing most of the forms distinguished as species by authors, and still retained by Prof. J. Agardh; and each of us,—Dr. Hooker very extensively,—has had an opportunity of verifying opinions arrived at in the study by observations made from the living plants on the sea-shore; and we have both, independently, arrived at the conclusion that all the forms separated by authors are referable to a single, and not *very* variable species. Many of these reputed species may indeed be found growing together on different parts of the same stem; the differences observed being either the result of age, or of a different degree of submersion, or other modifying cause.

II. NEREOCYSTIS, *Post. and Rupr.*

Stem filiform, simple, terminating in a club shaped air-vessel, from which springs a tuft of dichotomously divided leaves, formed by the continual splitting, from the base upwards, of an original, simple, terminal leaf. *Root* branching. *Fructification* unknown.

NEREOCYSTIS *Lütkeana*, *Post. and Rupr. Illustr. p. 9. t. 8. 9. Endl. Gen. Pl. 3rd Suppl. p. 27. J. Ag. Sp. Alg., vol. 1, p. 148. Kütz. Sp. Alg. p. 584. Fucus Lütkeanus, H. Mert. in Linn. 1829. p. 48. Hook. Bot. Misc. vol. 3, p. 3.*

HAB. North West Coast, at Norfolk Sound, *Dr. Henry Mertens*. (v. s. in Herb. T. C. D.)

I copy the following account of this remarkable plant from the paper of Dr. Henry Mertens, its discoverer :—

“A root, ramified in the manner of the *Laminarias* produces a stipes like pack-thread, and everywhere of uniform thickness, about two or three feet long, and suddenly swelling at the end into a perfectly round, large, bladder-nut. The upper portion of this hemispherical body bears a tuft of geminate leaves, mostly rising on

five petioles: but in the division of these petioles, there never exists such a symmetry as that the fifth is found exactly in the centre and opposite to the point of insertion of the stipes at the vesicle; rather, there are three on one side, and two only on the other. In some rare instances I noticed but four leaf-stems, two on either side. The summit of the vesicle always presented an open space: the leaves are lanceolate, sharply attenuated at both extremities, their substance like the frond of *Laminaria Phyllitis*, about one and a half to two feet long, and measuring two inches in their greatest breadth; some longitudinal nerves appear, of uncertain number, running from the base of the leaf to the middle, where they are lost in the substance. Such is the configuration of this fucus in a young state; when older it alters so as to be scarcely recognisable, and then only acquires that remarkable appendage, which I shall now proceed to explain. In advanced age, the stipes becomes immensely long, without however increasing proportionably in thickness; for whilst it remains at the base of the stoutness of packthread, its diameter, at ten or fifteen fathoms' distance, scarcely measures two and a half lines. Gradually the vesicle changes into a turnip-shaped or retort-like cylinder, more than a fathom long, measuring at its broadest dimension that supports the leaf near the end, 4—6 inches or even more in diameter, while the lower end gradually, and quite imperceptibly, loses itself in the stipes. The formation of the frond keeps an equally gradual advance: the leaves described above are numerously divided in their length, the nerves of the young leaves indicating their future points of separation. Entangled at their bases by matting together, these attain a very great length and an equal increase of breadth; the tuft now covering an immense surface with its crowded masses. In one specimen, by no means the largest, which I examined, I calculated that there were upwards of fifty leaves, each twenty-seven feet long. The Russians call this fucus (to which I had previously given the name of *Lutkeanus*, in honour of our worthy commander, who daily shows himself more zealous in favouring our natural history labours) *See Otter Kohl*, or the Sea Otter's Cabbage. The valuable animal, *Lutra marina*, makes particular choice of this seaweed as its favourite refuge and residence; delighting to rock and sleep on the long cylindrical bladders, which, like enormous sea-serpents, float on the surface of the water, and individually sweep between the little islands, rendering the channels impassible, even for boats. From the information that I collected from various Russians and Aleutians concerning its duration, this fucus is annual. In autumn it is cast in great quantities on shore by the then prevalent storms, where it soon decays, and in spring not the least trace of it is to be seen. The Aleutians employ the stipes, which are said sometimes to be forty-five fathoms long, for fishing lines: I purchased one of them. I once saw the Kadiakensers, in Sitcha, make use of the cylinder as a siphon, for pumping the water out of their Beidarkas; a use to which it is well known that the *F. buccinalis* is often applied at the Cape of Good Hope. Owing to the moist climate of Sitcha, the drying of this sea-weed is attended with considerable difficulty. I hardly ever succeeded in preserving a tolerable specimen of the cylinder or bladder, though I bestowed much pains and labour on the operation, for this part generally dissolves completely, or if dried, the leaves then become brittle as glass, and fall to pieces with the slightest touch. The opening of the bladder and

discharging the water which it uniformly contains, only hastens the process of decomposition."—*H. Mert. (translated) in Hook. Bot. Misc. 3, p. 3-5.*

Little is known of this singular Alga beyond the above graphic description, and the figure of Postells and Ruprecht. I earnestly recommend it to the notice of all collectors of plants on the North West Coast ; though it would appear to be confined to Russian America.

III. LESSONIA, *Bory.*

Stem cylindrical, solid, dichotomously branched, each branch terminating in a pair of lanceolate leaves. *Air-vessels* none. *Spores* collected in a thickened portion of the lamina of the leaves, and there forming a subdefined, dark-coloured patch, ellipsoidal, with hyaline perispore, and lying among densely packed, inarticulate paranemata.

Species of this genus probably exist on the North West Coast, but as yet I have received no certain information on this subject. The *Lessonia Sinclairii* from California, mentioned by Dr. Hooker, *Fl. Antarkt. vol. 2, p. 460*, must for the present remain undescribed. The name was given in MSS. to a specimen existing in Sir William J. Hooker's herbarium, having the habit of *Laminaria saccharina*, but a central patch or *sorus* of fructification, like that of the ordinary Lessoniæ. I have no means, at present, of referring to the original specimen, and neglected to make an accurate examination of it when it was named. It was gathered by Dr. Sinclair at San Francisco, and is the *Lam. saccharina* of *Harv. in Hook. and Arn. Bot. Beechey, p. 407.*

IV. ALARIA, *Grev.*

Root branching. *Frond* stipitate, membranaceous, with a percurrent cartilaginous midrib (a continuation of the stipes) ; the lower part of the stipe pinnated with ribless leaflets. *Spores* collected in a thickened, central portion of the leaflets, forming a definite, dark coloured patch, four spores contained within each pear-shaped perispore, myriads of which are vertically packed together among inarticulate paranemata.

A small genus inhabiting the colder regions of the Northern Atlantic and Pacific. The *lamina* which forms the wing, at either side of the midrib, or

prolonged apex of the stipes, is of a delicately membranaceous substance, and tears easily in an oblique direction from the margin to the midrib, and it is rare to find specimens of large size in which the upper half of the leaf is not reduced to tatters. During the growing season new ribbed membrane is, however, constantly developed at the base of the old winged portion, and by its upward growth supplies the place of the apex which is destroyed by the waves. In the young plant the stipes is very short and has no pinnæ. As the growth proceeds, it gradually lengthens and becomes much thicker and stronger, throwing out along its margin in the upper half, and immediately below the base of the leafy portion, narrow spathulate ribless leaflets. These are destined to contain the fructification, and are the nearest approach to a proper *receptacle* of fruit that is found within the limits of the Order. The barren leaflets are membranaceous, and not very different in substance from the ribbed leaf, except in being a little thicker; but those in which fruit is formed have their lower half, at least, incrassated, and gradually changed to a dark brown. The thickening is sometimes confined to the lower half of the leaflet, and sometimes extends to the whole surface. A vertical section through this mass of fructification shows it to be composed of innumerable *perispores*, formed out of the enlarged surface-cellules of the frond. Each perispore, at maturity, contains four spores. Numerous barren filaments or *paranemata* accompany the fertile perispores.

The midrib of *Alaria esculenta*, when stripped of the membrane, is eaten by the peasantry on the shores of Scotland and Ireland under the various names *Baddlerlocks*, *Henware*, *Honeyware*, and *Murlins*. If the first of these names signify that this esculent is *far from good*, it is perhaps the most appropriate of the whole; but I do not vouch for the authenticity of this derivation.

1. *ALARIA esculenta*, Grev.; midrib solid, scarcely wider than the stipes; lamina ovate at the base, decurrent along the stipe; pinnæ linear or cuneate. *J. Ag. Sp. Alg.* 1, p. 143. *Kütz. Sp. Alg.* p. 579. *Harv. Phyc. Brit.*, t. 79. *Fucus esculentus*, *Turn. Hist.*, t. 117. *E. Bot.* t. 1759. *Fl. Dan.* t. 417. *Laminaria musæfolia*, and *L. linearis*, *De la Pyl. Fl. Terr. New.* p. 31 and 37.

HAB. On rocks about low water mark. On the eastern coast, as far south as Cape Cod. Newfoundland. Also on the N.W. Coast, at least in Russian America. (v. v.)

Root of many grasping branches. *Stipe* naked at the base, cylindrical, from two to eight or ten inches long, and from two to four lines in diameter, pinnated in its upper half with numerous ribless, linear-spathulate leaflets, which at length become crowded together; above these leaflets the stipe is winged at each side with membrane, and passes gradually into the cartilaginous midrib of the foliaceous frond, which is from three to twenty feet long or more, and from two inches to eight or ten inches or more in width. This leafy portion is very thin and easily torn, of a clear olive when growing, becoming greener and more transparent when dried.

The masses of fructification are reddish brown, much thicker than the leaves in which they lie.

2. *ALARIA Pylaii*, Grev. ; midrib solid, scarcely wider than the stipes, lamina cuneate at the base, decurrent along the stipes for a considerable space ; pinnæ obovato-spathulate. *J. Ag. Sp. Alg. vol. 1, p. 143.* *Kütz. Sp. Alg. p. 579.* *Laminaria Pylaii*, Bory. *De la Pyl. Fl. Ter. Neu. p. 29.*

HAB. On rocks near low-water mark. Newfoundland, *De la Pylaie*. (v. s. in Herb. T.C.D.)

Scarcely differing from the preceding, with which it has probably been sometimes confounded. It is chiefly marked by the broader and more obovate pinnæ ; the cuneate base of the frond is a very indefinite character.

3. *ALARIA fistulosa*, Post. and Rupr. ; "Midrib fistular, inflated, at intervals constricted and septigerous ; lamina delicately membranaceous ; pinnæ linear, rounded at the apex, attenuated at base, sessile."—*Post. and Rup. Illustr. p. 11, t. 16.*

HAB. Illuluk Bay, Unalashka, *Postells and Ruprecht, l. c.*

4. *ALARIA marginata*, Post. and Rupr. ; "Midrib solid, rather broad ; lamina thin but leathery," (chartaceo-coriacea) ; "pinnæ linear, rounded at the base and apex, stipitate, coriaceous, entire at the margin, plane, bordered by a shining stripe (fascia nitida cinctis)."—*Post and Rupr. Illus., p. 11.*

HAB. At Unalashka, *Postells and Ruprecht, l. c.*

V.—COSTARIA, Grev.

Frond stipitate, undivided, flat, three to five ribbed, the ribs sub-parallel, radiating from the apex of the stipe. *Fruit. . . ?*

The stipe is simple, solid, flattened, and marked with numerous elevated longitudinal striæ, and so continued through a simple, linear, or ovate lamina, that the striæ of the stipe are produced in ribs. These ribs are three or five ; they are united in the stipe ; separated, they run through the lamina sub-parallelly, and approach again at the apex. The lamina is mostly wrinkled and bullated, often perforated between the ribs, the perforations irregular. *J. Ag. l. c.*

1. *COSTARIA Turneri*, Grev. ; stipes flat, expanding into a linear-lanceolate five-ribbed lamina. *J. Ag. Sp. Alg.* vol. 1, p. 139. *Kütz. Sp. Alg.* 580. *Fucus costatus*, *Turn. Hist.* t. 226.

HAB. On the North West Coast, *Mr. Menzies*.

“*Frond* solitary, rising with a stipe about an inch in length, marked from top to bottom with prominent, nearly parallel striæ, cylindrical, and of the size of a crow’s quill at its origin, but almost immediately becoming compressed, and soon after flat, gradually expanding, too, as it rises, but so slowly that at the top it is scarcely above a line in diameter ; it here suddenly expands into a single, flat, undivided leaf, a foot and a half or more long, nearly linear, about two inches wide, quite entire, and slightly waved at the margin, at the base attenuated ; the surface marked all over with irregular transverse wrinkles, and having five parallel ribs running through it from top to bottom. *Colour* a pale, dirty yellow in the stipe, in the leaf olive-brown, and semi-transparent. *Substance* of the stem woody, of the leaf membranaceous.”—*Turn. Hist.* 4, p. 72.

2. *COSTARIA Mertensii*, J. Ag. ; “stipes flat, expanding into a cordato-ovate five-ribbed lamina.”—*J. Ag. Sp. Alg.* 1, p. 142. *Costaria Turneri*, *Post. and Rupr.* t. 24.

HAB. North West Coast, *Dr. H. Mertens*.

I think this must be merely a broad leaved form of the last.

VI. LAMINARIA, *Lamour*.

Frond stipitate, coriaceous or membranaceous, flat, ribless, undivided or irregularly cleft. *Fructification*, cloud-like patches of spores, imbedded in the thickened surface of some part of the leafy expansion.

The plants commonly known as *Oarweed*, *Tangle*, *Devil’s Apron*, *Riband-weed*, *Sole-leather-kelp*, &c. belong to this genus, which is more numerous in species, and possessed of a wider geographical range than any other of the Order. With the exception of *L. Fascia*, which is only a few inches long, they are all plants of a large size, varying from three to twelve, or twenty feet in length. They commence to grow about low-water mark, and descend, beyond that limit, to the depth of five to ten fathoms.

Many are perennial ; the stipe remaining from year to year and the frond falling away. The new frond is developed between the apex of the stipe and the base of the old frond, and at first appears like a flattening and widening of the apex of the

stipe. This flattened portion gradually lengthens, assuming the normal form of the species, and carries at its apex the old leaf, which is about to be changed. The point of cohesion of this leaf becomes less firm, and gradually the now decayed lamina falls off, leaving the young frond to crown the stipe in its place.

1. *LAMINARIA Fascia*, Ag. ; stipe very short, slender, flattened, expanding gradually into a membranaceous, broadly oblong, wedge-shaped, lanceolate, or linear frond. *Harv. Phyc. Brit. t. 45. Lam. Fascia, cæspitosa et debilis, J. Ag. Sp. Alg. vol. 1, p. 129-130. Phyllitis Fascia et debilis, Kütz. Sp. Alg. p. 566.*

HAB. On rocks and stones, near low-water mark. Fort Hamilton, N. Y. *Capt. Pike and Mr. Hooper. Halifax, W. H. H. (v. v.)*

Root, a small disc. *Stipe* as thick as hog's bristle, half an inch long, filiform at base, compressed upwards and gradually widening into the cuneate base of the frond. *Lamina* very variable in form, 2—12 inches long, from a quarter inch to two inches broad, sometimes abruptly cuneate at the base, sometimes much attenuated, either lanceolate, oblong, or linear, or oblong-ovate ; in some specimens remarkably obtuse, in others tapering more or less to the point. Margin waved or flat. *Colour* when growing a clear chestnut brown, changing to greenish olive in drying.

I can by no means distinguish from one another the three species of Prof. Agardh, above referred to this. The form of the frond is most variable, even in the same tuft, and the gradations between the several forms so complete, that if you examine a sufficient number of specimens not specially selected as typical, there can be no difficulty in tracing the narrowest and most cuneate into the widest and most ovate. *L. Fascia* is widely distributed, being found also on the Atlantic and Mediterranean shores of Europe ; and at the Falkland Islands in the Southern Atlantic.

2. *LAMINARIA lorea*, Bory ; stipes rising from a branching root, flat, winged above, dilating into a linear-ensiform, membranaceous, very long frond, entire or cleft at the apex. *J. Ag. Sp. Alg. vol. 1, p. 130. L. tæniata, Post. and Rupr. t. 38, f. (fide Ag.). L. saccharina, var. Kütz. Sp. Alg. p. 574.*

HAB. Shores of Newfoundland, *Despreaux.*

Stipe 3—4 inches long, flat from its origin, dilated above, and winged with a thinner margin. The wing of the stipe is expanded into the lamina of the frond, the stipe itself (or its thickened portion) being continued in furrows through the lower part of the lamina. *Lamina* several feet long, an inch and a half wide, at each end much attenuated. *J. Ag. l. c.*

I am not acquainted with this plant, said to be a very distinct species by Agardh, from whom I copy the above description.

3. *LAMINARIA dermatodea*, De la Pyl. ; stipes rising from a branching root, terete below, compressed or flattened above, dilating into a cuneate-oblong simple frond afterwards becoming cordate at base, and palmately cleft from the apex. *J. Ag. Sp. Alg.* 1, p. 131. *Phyllitis dermatodea*, Kütz. *Sp. Alg.* p. 567.

HAB. On rocks, at and below low-water mark. Newfoundland, *De la Pylæie*. (v. s. in Herb. T.C.D.)

Stipe 3-4 inches long, in the young plant compressed, in the full-grown altogether flat, passing into the base of an oblong or lanceolate frond, which in the young plant is entire, but which at last, becoming more dilated and with a more cordate base, is cloven into several segments and assumes the habit of *L. digitata*.

I have seen only young specimens of this species, and in them the apex is imperfect. They were collected by Despreaux and communicated to me by *M. Lenormand*.

4. *LAMINARIA saccharina*, Lamour. ; stem cylindrical, solid, short, expanding into a cartilaginous or submembranaceous, lanceolate or oblong, undivided frond. *J. Ag. Sp. Alg.* vol. 1, p. 132. *Kütz. Sp. Alg.* p. 574. *Harv. Phyc. Brit.* t. 289. *Fucus saccharinus*, L. *E. Bot.* t. 1376. *Turn. Hist.* t. 163. *Lam. Lamourouxii* ? *Bory, Dict. Cl. Hist. Nat.* 9, p. 189.

HAB. On rocks in the sea, from low-water mark to four or five fathoms. Common on rocky shores, from Greenland to New York ; and cast up from deeper water on the New Jersey coast. (Its southern limit not ascertained beyond Long-branch, N. J.). (v. v.)

Root of several branching fibres, forming a conical holdfast. *Stem* from a few inches to a foot or more in length, from a quarter to half an inch in diameter, terete, compressed at its upper end, and gradually dilating into the base of the terminal, undivided lamina. *Lamina* very variable in its proportionate length and breadth, sometimes linear-lanceolate, sometimes ovato-lanceolate, sometimes elliptical, acute or obtuse, or drawn out at the apex into a long caudate prolongation, from one to six or ten feet in length, and from one to twelve inches in breadth, flat, or very much curled at the margin, and at length over the whole surface ; sometimes regularly transversely wrinkled through the middle of the lamina, sometimes irregularly bullated. *Substance* in some varieties membranous, in others cartilaginous or leathery, or even horny in some. *Colour* of the leaf when young a greenish olive, browner as it grows old.

Numerous varieties, which perhaps demand future study, occur on the American coast. The *Laminaria Lamourouxii* of Bory, which has been sent me from Boston Harbour by Prof. Asa Gray, and of which I also possess an authentic specimen from Newfoundland, looks almost like a species, with its thickish, broadly elliptical, scarcely waved frond, and its slightly branching root ; but I am not sufficiently

acquainted with it to say whether it has claims to be regarded as anything more than a form. Prof. J. Agardh refers it unhesitatingly to *L. saccharina*, and it must be confessed, that if we separate it on the mere characters assigned by M. Bory, we must be prepared to admit to specific rank many other forms now referred to *L. saccharina*.

5. *Laminaria longicruris*, De la Pyl. ; Stipes very long, slender at the base, hollow and inflated in the middle, and gradually tapering to the apex ; frond undivided, ovato-lanceolate, membranaceous, obtuse. *J. Ag. Sp. Alg. vol. 1, p. 135.* Kütz. *Sp. Alg. p. 576.* Harv. *Phyc. Brit. t. 339.* (TAB. VI.)

HAB. In deep water, from five to ten fathoms (or more?). Very abundant on the American shores, from Greenland to Cape Cod. Newfoundland, *De la Pylæie*. Bahama Islands, *Chauvin.* (v. v.)

Root of many slender and much branched, clasping fibres, which issue at irregular intervals from the lower part of the stipe. *Stipe* from eight to twelve feet in length, very slender at the base, and there solid, gradually widening upwards, and soon becoming hollow ; at length, toward the middle, widened to upwards of an inch in diameter, and thence tapering to the apex, and terminating in the broadly cuneate base of the lamina. *Lamina*, when full grown, 6 to 8 feet in length, and from two to three feet in width, oblong-lanceolate or oval, very much waved at the margins, and obtuse at the apex, of a thinner substance than in *L. saccharina*. *Colour* of the stem yellowish brown, pale ; of the lamina a beautiful pale greenish olive.

This noble species, though having much general resemblance to the preceding, is at once distinguished from every form of it by the very long, hollow stem, tapering to both extremities. It is by far the most abundant species on the northern coasts, and gradually diminishes, in the number of individuals, and in the size and luxuriance of growth, as it extends southward. In Boston Bay it is still plentiful, though of much smaller dimensions than at Halifax, where it is the chief ornament of the sub-marine flora. I have seen no specimen from a more southern locality than Cape Cod ; but M. Chauvin is said to have received it from the Bahamas. In Europe it is scarcely known to grow beyond the limits of the Arctic Sea, whence water-worn specimens occasionally reach the coasts of Scotland, and of the north of Ireland.

PLATE VI. *Fig. 1.* A young frond of *LAMINARIA longicruris* ; one third of the natural size ; *fig. 2.* part of the hollow stipes of a full grown plant, the *natural* size.

6. *LAMINARIA trilaminata*, Harv. MSS.—Olney, in Proceedings of Providence Franklin Society, vol. 1, p. 39.

HAB. Floating near Narragansett Pier, R. I. *Mr. Olney*. (v. s.)

I introduce this undescribed and scarcely known plant, because it has already obtained publicity in Mr. Olney's list of Rhode Island plants, quoted above ; but I am unable to give a satisfactory description from the few fragments that have reached me ; and probably, after all, these may belong to some strangely anomalous form of *L. saccharina*. The fragments sent me by Mr. Olney and Professor Bailey are labelled as part of a large Alga resembling *L. saccharina* in appearance, but having a trilaminate frond ; that is, from the centre of the lamina, along its whole (?) length, there projects a wing or additional lamina, making, with the two halves of the true leaf, a third lamina. Nothing is known of the stipes.

7. *LAMINARIA digitata*, Lam. ; stem robust, woody, terete below, compressed above, expanding into a leathery, oblong, or ovate frond, which is deeply cleft into many linear segments of irregular breadth. *J. Ag. Sp. Alg. vol. 1, p. 134. Harv. Phyc. Brit. t. 223, and t. 338. Hafgygia digitata, Kütz. Sp. Alg. p. 577. Phyc. Gen. t. 30, 31. Fucus digitatus, L. Turn. Hist. t. 162. E. Bot. t. 2274.*

HAB. On rocks, at and below low-water mark. Common as far south as Cape Cod. Narragansett Pier, R. I., *Mr. Olney*. (*floating only*). (v. v.)

Root formed of many stout branching holdfasts united together in a conical mass. *Stipe* from two to six feet long, cylindrical below, from a quarter inch to an inch in diameter at base, solid, tapering, and becoming compressed upwards, and terminating in the base of a standard-like broad lamina. *Lamina* from one to five feet long, or more, from one to three feet wide, deeply cleft from the apex to near the base into many linear strap-shaped segments of uncertain breadth. *Substance* of the stem woody, but flexible, horny when dry ; of the lamina leathery. *Colour* olive, becoming dark in age.

Possibly more than one species is here confounded. Some varieties, like that figured in *Phyc. Brit. t. 338*, are very narrow, with very much compressed, or even flattened stipes, and of a dark blackish-brown colour and glossy surface. Others, which I have from Boston Bay, have dried extremely pale, and though I have not seen perfect specimens of these, I remember to have noticed on the beach near Nahant some forms of pale colour and with very flat stems, which may belong to a peculiar species. The limits of species among these gigantic Algæ can rarely be determined from Herbarium specimens alone, and should be fixed by persons familiar with the plants in their places of growth, and who have watched the development of the frond through all its stages.

VII. AGARUM, *Bory.*

*Fron*d stipitate, coriaceous, flat, pierced in all parts with roundish holes, and traversed by a cartilaginous midrib which is a prolongation of the stipes. *Fructification*, cloudlike patches of *spores*, imbedded in the thickened surface of some part of the perforated expansion.

A remarkable genus peculiar to the northern parts of the Atlantic and Pacific Oceans, on the American and Asiatic shores. The common American species (*A. Turneri*) is well known in the north eastern states as the *Sea Colander*, a name aptly expressive of the perforated frond. The holes in the membrane exist at all ages, but increase in size and circularity, as well as in numbers, as the growth proceeds. They are at first merely narrow slits, and commence to be formed near the midrib, where the active cell-division seems to take place. As in *Laminaria*, the newest portion of the leaf is at the base, where the stipes enters; and the apex is continually worn out and thrown off. The *fructification* is found on old fronds late in the autumn, or early in winter, and forms very dark coloured patches of uncertain extent on the pierced membranes.

1. AGARUM *Turneri*, Post. and Rupr.; stipes compressed, coriaceous, continued as a flattened midrib through the frond; lamina membranaceous, its nearly circular holes with flat margins, and of various sizes intermixed. *J. Ag. Sp. Alg. vol. 1, p. 141.* *Kütz. Sp. Alg. p. 580.* *Fucus Agarum, Turn. Hist. t. 75.* *Fl. Dan. t. 1542.* (TAB. V.)

HAB. On rocks and stones, &c., from low-water mark to a depth of 5—10 fathoms. Very abundant on the Eastern Coasts, from Greenland to Cape Cod. North West Coast, at least in Russian America. (v. v.)

Root much branched, formed of many clasping, dichotomous fibres, interwoven together. *Stipe* from one to four lines wide, and from two inches to a foot in height, compressed, coriaceous, becoming flattened and sensibly widened where it meets the lamina, through which it is then continued as a midrib. The width of this midrib varies much in different specimens of the same age; in some being scarcely wider than the stipe, and in others three or four times that width. *Lamina* oblong, at first elliptical, then becoming ovate, and at length deeply cordate at the base, the margin at the same time being changed from nearly flat to be very much waved and curled, this portion of the frond continuing to be developed after growth has nearly ceased within it. The whole lamina is pierced, at short distances, with roundish holes, which commence of small size and gradually widen; these are irregularly mixed together, large and small, in all parts of the leaf, the smaller holes being of later formation than the larger. The new growth of membrane chiefly takes place where the stipe enters at the base, but also for a considerable time near the margin of the lower half of the leaf. The substance of the leaf is membra-

naceous, soon drying ; that of the stipe and midrib more coriaceous, or cartilaginous. The colour is a darkish olive-green, becoming brown in age. The leaves, when full grown, are often ten or twelve feet in length, and two or three feet wide.

PLATE V. *Fig. 1.* A young frond of *AGARUM Turneri*, the *natural* size ; *fig. 2*, part of a thin vertical slice, through a *sorus* and the outer coats of the frond ; *fig. 3*, *spores*, in their *perispores*, from the *sorus* ; *fig. 4*, a *spore* isolated :—all the latter figures more or less highly *magnified*.

2. *AGARUM pertusum*, Mert. ; “stipes compressed, coriaceous, continued as a scarcely widened midrib ; lamina membranaceous, its holes when young furnished with a margin raised at one side, and formed by openings in the bullated membrane.” *J. Ag. Sp. Alg. l. p. 142.* *Kütz. Sp. Alg. p. 580.* *Post. and Rupr. t. 23.*

HAB. Newfoundland, *De la Pylæie* (fide J. Ag.)

I am not acquainted with this species, which is said to have the holes much more irregular in shape and fewer in number than those of the preceding species ; also of more equal size, and smaller, rarely two lines in width ; and that they arise from the bursting of a bullated membrane.

A third species (*A. Gmelini* *Post. and Rupr. p. 11. t. 20, 21,*) is described from the Northern Pacific, characterised chiefly, as it would seem, by having a midrib twice as wide as the stipes, and holes with undulated margins ; but I fear these characters can hardly be considered as alone sufficient to distinguish a species, for I find among a number of specimens picked up on Nahant Beach, great diversity in the comparative breadth of the midrib, and form of the holes. In some of my specimens, where the leaf measures 26 inches in length, the midrib is but two lines wide ; and in others of somewhat inferior superficies, it is at least five lines, the stipe being in the same specimens but two lines wide. I find similar variations in specimens collected at Halifax, and that it is impossible to fix limits between those with narrow, and those with wide stipes. It will remain to be seen whether observers on the shore can detect characters, existing at all ages, between those specimens with wide midribs and those with narrow. In many that I possess, the apex of the frond, both midrib and lamina, is strongly curved or hooked to one side, and this seems generally to occur in those with wide ribs.

VIII. THALASSIOPHYLLUM. *Post. and Rupr.*

Frond with subdistinct leaves ; the leafy expansions formed by the evolution of a lamina, spirally developed round a branching stipe ; each leafy-lobe ribless,

reniform, undivided, pierced in all parts with roundish holes. *Fructification*, cloud-like patches of *spores*, imbedded in the thickened surface of some part of the perforated leaf-lobes.

This genus is very nearly related to the preceding, from which it differs in having a branching stipe, round which a perforated lamina, partially divided into definite leaves, is spirally coiled. There is but one species yet known, viz:—

THALASSIOPHYLLUM *Clathrus*, Post. and Rupr. Illustr. t. 18, and t. 19. *J. Ag. Sp. Alg.* 1, p. 139. *Kütz. Sp. Alg.* p. 581. *Fucus clathrus*, Grev. *Hist. Fuc.* t. 33.

HAB. On the shores of Russian America. (v. s. in Herb. T. C. D.)

My specimens of this are so imperfect, that I prefer copying the following account given by Dr. H. Mertens of its appearance in a living state:—

“The ocean hardly boasts a more beautiful production than this; it is generally about the height of a man, very bushy and branched, each branch bearing a broad leaf at its extremity, which unfolds spirally, and by this gradual development produces the stipes with its branches and lateral divisions. A spiral border, wound round the stipes, indicates the growth of the frond. The frond presents a large, convex, bent lamina, without nerves; or to a certain degree a leaf, of which one half is wanting, for the stipes may be considered as an excentric nerve. A number of rather long, narrow perforations, arranged in a radiate form, give the frond the appearance of a cut fan; these foramina being coeval with the formation of the frond, and apparently not owing to inequalities of substance. At first, these foramina, which are situated near the stipes, and where the frond is bent in, are round, and have their margins turned outwards; but by the subsequent growth of the frond they become longer, and their margins disappear; in the middle of the frond they are like true clefts, but nearer the margins, from the greater development of the leafy substance, they are more contracted in their breadth and therefore seem round. The frond has a complete and entire margin, but is frequently torn; its substance is coriaceous. I have never detected any fructification. The root resembles that of the larger *Laminarias*, but is more woody. This fucus is very plentiful in the bay of Illuluk, and round the whole island of Amaknak. It clothes the rocky shore, like a thick hedge, for a space of 60 or 80 feet, forming, at a little distance, a very pleasing feature in the scenery.” *H. Mert. in Hook. Bot. Misc.* 3, p. 5, 6.

IX. CHORDA, *Stack.*

Root scutate. *Frond* simple, cylindrical, tubular; its cavity divided by transverse membranes into separate chambers. *Fructification* a stratum of obconical spores, covering the whole external surface of the frond.

1. *CHORDA filum*, Stack. ; frond cartilaginous, lubricous, clothed with pellucid hairs, filiform, very long, tapering to each extremity, not constricted at the dissepiments. *Grev. Alg. Brit. t. 7.* *Harv. Phyc. Brit. t. 107.* *Kütz. Sp. Alg. p. 548.* *Scytosiphon filum*, Ag.—*J. Ag. Sp. Alg. 1, p. 126.*

HAB. On rocks, etc. in the sea, between tide-marks, and extending to 4—10 fathoms depth, especially in deep, quiet bays. Common on the northern shores. (v. v.)

Root a minute disc. *Fronde*s from one to ten, twenty, or even forty feet in length, according to depth of water, scarcely twice as thick as hog's-bristle at the base, gradually increasing in thickness to the middle and there from a quarter inch to nearly half an inch in diameter, and again gradually diminishing toward the apex, which is of equal tenuity with the base. This threadlike frond is cylindrical, hollow, divided at short intervals by very thin membranes, into chambers or joints, which are not visible externally; it is slimy to the touch, and clothed, at an early stage, with very dense, slender, gelatinous filaments, which generally disappear as the plant advances to maturity, but may sometimes be found on old plants, especially on such as grow in quiet, deep bays where they are little exposed to the action of waves. The *substance* is cartilaginous and firm, and very tough when recent. The *fructification* covers the whole external surface of old plants, and consists of obconical, vertical spores, supported on long pedicels, by which they are attached to the outer row of cellular tissue. Mixed with these are found numerous, narrow, elliptical, transversely striated cells, which may be antheridia. The walls of the tubular frond are formed of several rows of hexagonal, elongate cells, placed end to end, and forming longitudinal threads, glued together by the sides. Of these the inner ones are of large size; the outer, minute and more densely packed together.

2. *CHORDA lomentaria*, Lyngb.; frond membranaceous, constricted at distant intervals; the interstices inflated. *Lyngb. Hyd. Dan. p. 74, t. 18.* *Harv. Phyc. Brit. t. 285.* *Chorda filum*, ζ. *lomentaria*, *Kütz. Sp. Alg. p. 548.* *Scytosiphon lomentarium*, *J. Ag. Sp. Alg. vol. 1, p. 126.*

HAB. On rocks and stones, &c. in tide pools. On the eastern coast, from British America to Charleston, S. C. (v. v.)

Root a small disc. *Fronde*s from eight to twelve or eighteen inches in length, tapering at the base to the diameter of horse hair, attenuated upwards, either to a bluntish or a very fine point, from two to four lines in diameter at the greatest breadth, cylindrical, constricted at irregular intervals and furnished with a transverse septum at each constriction. The walls of the tube are composed of a thick layer of large, polygonal cells, of which the outer ones are gradually smaller; on the outside of which, forming the periphery, is a stratum of radiating, close-packed, moniliform

filaments. These are only found in their full development on mature specimens. *Colour* a brownish or greenish olive. *Substance* membranaceous and soft.

In habit this plant has more resemblance to *Asperococcus echinatus* than to the preceding species, but the structure of the walls is more in accordance with *Chorda*. There is also considerable affinity with the Antarctic *Adenocystis*, a little group that scarcely differs essentially from *Chorda*, with which Kützinger unites it. I cannot agree so well with that author in making *C. lomentaria* merely a variety of *C. filum*, from which it has latterly been kept separate by most authors, and from which it differs in many essential characters.

ORDER IV.—DICTYOTACEÆ.

Dictyotæ, Grev. *Alg. Brit.* p. 46. *J. Ag. Sp. Alg.*, vol. 1, p. 68. *Endl. 3d. Suppl.*, p. 24. *Dictyotæ*, *Encæliæ*, and part of *Chordeæ* and *Phycoserideæ*, Kütz., *Phyc. Gen.* pp. 337, 336, 333, 296. *Dictyotidæ*, Lindl. *Veg. Kingd.* p. 22.

DIAGNOSIS. Olive-coloured, inarticulate seaweeds, whose *spores* are superficial, and disposed in definite spots or lines (*sori*). (*Frondose*, or rarely *filiform* plants of small or mediocre size, and membranaceous texture ; their surface reticulated with large cells.)

NATURAL CHARACTER. *Root* usually a minute membranous disc or holdfast ; sometimes a conical fleshy mass of large size, densely clothed with curled, wool-like jointed hairs. *Fronds* of an olive-green or olive-brown colour, mostly becoming paler on exposure to the air ; of a membranaceous, flexible substance, rarely leathery or cartilaginous, and scarcely at all juicy : composed of two or more strata of cells, of which the inner ones are largest, usually empty, and either quadrate or appear so in profile. These large cells, seen through the smaller superficial and coloured cells which form the actual coating of the frond, give to its surface, when examined under a lens of moderate power, a netted appearance which is highly characteristic, and has suggested the name by which the Order is distinguished. In some, these internal cells form a regular honey-combed tissue of twelve-sided cells ; but in others they are cylindrical, arranged in longitudinal series or filaments which, however, cohere closely throughout their length, forming a membrane, and are not separable without laceration.

In external habit the plants of this Order exhibit considerable variety. In some of the humblest, the frond is an unbranched thread formed of numerous cells concentrically disposed round an imperfectly hollow axis. Then we have bag-like, simple fronds, as in *Asperococcus*, formed as it were by the inflation of such a

thread, accompanied by the expansion of the walls into thin membranes. Next, in *Punctaria*, the bag becomes flattened into a nerveless leaf. In higher groups the tubular or flattened frond is divided into a branching stem, which, however, does not develop any separate leafy organs. In one case (*Haliseris*) this stem is winged throughout with membrane, or may be described as a midribbed branching frond. Among the most highly developed genera (*Zonaria* and *Padina*) the frond shows a tendency to assume a fan-shaped outline, having a definite, subcircular margin at the summit, and gradually widening from the base upwards. Such fronds are usually marked at regular intervals with concentric lines, and are formed of longitudinal rows of cells collaterally united in membranes; the rows diverging as they grow, and new rows of cells being introduced in the interspaces. In many, and perhaps in all, the growing frond is clothed with exceedingly slender, jointed, and often colourless hairs, which sometimes, whilst expanded under water, decompose the rays of light, and cause the frond to display brilliant prismatic colours. These hairs are prolongations of the surface-cells, or issue from their sides, and are probably organs of the same kind as the pencilled fibres already noticed in the *Sporochnaceæ*.

The fructification exhibits considerable diversity of aspect in the various genera, but the characters are of minor value, chiefly relating to the form and position of the masses of fruit. In all, the *spores* are developed externally, either being formed from the surface-cells, which, when fertilized, stand out prominently from the ordinary cells; or from those cells immediately beneath the epidermis, in which case the spore-cell bursts through the external coat, carrying it outwards as a separated membrane. Usually each perispore contains but a single sporular mass, but in *Padina*, four spores are found at maturity in each perispore; and in *Cutleria*, eight spores. In some genera the spores are scattered singly over the surface of the frond; but in by far the greater number they are collected into definite spots, or *sori*, which are round, oblong, or linear, and are either dispersed irregularly over the whole surface, or confined to a certain part of it; or else ranged in transverse, horizontal, or concentric bands. In some, both scattered and aggregated spores are found on the same individual, or on different individuals of the same species. In such cases, the scattered spores are usually of larger size and paler colour than the aggregated ones, and their contents appear to be different. They have sometimes been supposed to be *antheridia*, but have not, as yet, been examined with sufficient care. The spores in most cases are accompanied by barren, jointed hairs, or *paranemata*, which appear to be formed from the same parts as the fertile spores, but to have developed into numerous cells. In *Stilophora* these paranemata compose the greater part of the warts of fructification. In some of the more perfect forms, as in *Cutleria* and *Padina*, *antheridia* have been noticed; these are sometimes found on the same individuals as the spores, and sometimes on different individuals.

This Order is of decidedly rare occurrence on the American coast, and scarcely attracts much notice, from the amount of individuals representing the species,

until we proceed as far south as Florida, where, on the Keys, several kinds occur in such abundance as to be conspicuous among the ordinary shore plants. This increase in numbers to the southward is characteristic of the Dictyotaceæ in general. Very few are found in high latitudes, and they gradually become more numerous, and of higher type of structure, the nearer we approach the torrid zone. Those which occur in temperate waters show their propensity for warmth by growing in shallow tide-pools near high-water mark, where they can enjoy a warm bath for many hours of a summer's day. Thus *Padina Pavonia*, which, on the American shore, is not found farther north than the Florida Keys, in lat. 25° , where it inhabits a region extending below low-water mark, reaches the latitude of 51° on the south coast of England, its farthest observed northern limit ; but there it is found only in warm pools near high-water mark, and in sheltered situations. This plant has a very wide distribution, being a native of all the warmer parts of the Atlantic, Pacific, and Indian Oceans, as well as one of the most abundant shore-plants in the Mediterranean. It is possible that more than one species may be confounded under this name, but no satisfactory diagnostic characters have yet been pointed out. *Dictyota dichotoma* is equally cosmopolitan, and has been noticed in the cold waters of the Antarctic Ocean, as well as on the shores of New Zealand, the Cape of Good Hope, and on the western coast of South America. Of the genus *Haliseris*, which is scarcely represented on the North American coasts, ten species are known, all of them tropical or sub-tropical ; although one (*H. polypodioides*) extends far to the north, and has been traced from the Canary Islands (lat. 28°) along the Atlantic shores of Europe, as far as lat. $53^{\circ} 45'$ on the west of Ireland : and if the Tasmanian specimens and those reported from the Brazilian shores really belong to the same species, it has a nearly equal dispersion in the Southern Ocean.

None of the Dictyotaceæ are used in the arts.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

* *Frond flat, dichotomous, traversed by a midrib.*

I. HALISERIS.

** *Frond flat, without midrib.*

† *Frond fan-shaped, vertically cleft.*

II. PADINA. *Sori* linear, concentric, bursting through the epidermis.

III. ZONARIA. *Sori* roundish, scattered.

IV. TAONIA. *Sori* linear, concentric, superficial, alternating with scattered solitary spores.

†† *Frond linear, dichotomous.*

V. DICTYOTA.

†† *Frond undivided.*

VIII. PUNCTARIA.

IX. SORANTHERA, Post. and Rupr. (*I do not see how this differs from Punctaria.*)

*** *Frond cylindrical, or bag-like.*

† *Branched.*

VI. STILOPHORA. *Sori* wart-like, composed of spores and moniliform threads.

VII. DICTYOSIPHON. *Spores* either solitary and scattered, or collected into dot-like *sori*.

†† *Unbranched, bag-like.*

X. ASPEROCOCCUS.

**** *Frond pierced with round holes, lace-like.*

XI. HYDROCLATHRUS.

1. HALISERIS. *Tozzetti.*

Root coated with woolly hairs. *Frond* flat, linear, membranaceous, traversed by a cartilaginous midrib. *Spores* collected in naked *sori*, disposed in longitudinal lines at either side of the midrib, and rising from both surfaces of the membranous frond. *Paranemata* forming groups separate from the sporiferous *sori*.

This is the only genus in the Order in which the frond is traversed by a midrib; and one species (*H. Areschougia*, J. Ag.) is described as being nerveless. In most species the membranous border of the frond tears with ease in an oblique direction toward the midrib; so that it is rare to find specimens of full size in which the lower part of the fronds is not much jagged. The margin is either entire, or minutely denticulate, and is sometimes thicker than the rest of the membrane. In two species the midrib throws off lateral secondary nerves which traverse the frond toward the margin, ascending obliquely. Of the ten species known, four are American, four South African, one Australian and Indian, and one a native of the tropical and temperate regions of the Eastern Hemisphere. The name, derived *ἅλς* and *σερίς*, is spelled *Halysaris* by Agardh, &c.

1. *HALISERIS delicatula*, Lamour. ; frond delicately membranaceous, winged from the base, dichotomous ; with very patent linear segments and rounded angles ; the margin very entire, somewhat thickened. *J. Ag. Sp. Alg.* 1, p. 116. *Kütz. Sp. Alg.* p. 562. (TAB. VII. A.)

HAB. On the shores of Mexico, *J. Agardh.* (v. s. in Herb. T.C.D.)

Fronds densely tufted, three or four inches long, and from one to two lines in breadth, thrice or four times forked, the forkings an inch or more apart, widely spreading or divaricate, and somewhat flexuous. *Segments* linear, obtuse, with an entire, slightly thickened margin, distinctly marked by a depressed line, and formed of smaller and more vertical cells than the interior portion of the membrane. *Sori* minute, oblong, forming a line at each side of the midrib. *Substance* very thin and delicate, composed of oblong cells, ranged in series proceeding obliquely from the midrib to the margin. *Colour* very pale, greenish-olive. I have not seen Mexican specimens, and have taken this description and prepared the figure given, from specimens collected at Pernambuco, and presented by Dr. Areschoug, to the Herbarium of the University of Dublin.

PLATE VII. A. *Fig. 1.* Plant of *HALISERIS delicatula* ; the *natural* size ; *fig. 2*, a segment, slightly *magnified* ; *fig. 3*, a small portion of the same, with a *sorus* ; *fig. 4*, *spores* : both more or less highly *magnified*.

II. PADINA. *Adans.*

Root coated with woolly hairs. *Frond* flat, ribless, fan-shaped, marked at regular distances with concentric lines, and fringed with articulated hairs ; the apex involute. *Fructification*, linear, concentric *sori*, formed beneath the cuticle of the upper surface of the frond, and bursting through it ; and containing at maturity, numerous obovate, hyaline perispores fixed by their bases, each perispore enclosing four spores. *Paranemata* club-shaped, articulate, disposed in concentric lines alternating between the *sori*.

Four species of this genus are retained by Agardh, who admits the difficulty of distinguishing them by exact characters. All have very similar fronds, all inhabit the warmer parts of the sea, and *P. Pavonia* at least is subject, even in the same locality, to variations almost as great as those which have been fixed on by authors, as characteristics of the several supposed species. But if there be a difficulty in distinguishing these plants, supposing them to be really different in specific character one from another, there is none in recognising our common species among all

other Algæ ; for its form and substance are strikingly peculiar. Its fan-like shape, and its property of reflecting prismatic colours whilst growing under water, have won it the popular name of *Peacock's-tail*.

1. PADINA *Pavonia*, Lamour. ; frond between membranaceous and coriaceous, broadly fan-shaped, entire or deeply and variously cleft, each lacinia being then fan-shaped, powdery on its outer surface ; concentric lines numerous. *Harv. Phyc. Brit. t. 91. J. Ag. Sp. Alg. 1, p. 113. Zonaria Pavonia, Kütz. Phyc. Gen. t. 22. f. 1. Sp. Alg. p. 565. Ulva Pavonia, Linn. E. Bot. t. 1276. (TAB. VII. B.)*

HAB. On stones, &c. about low-water mark. Annual. Spring and early summer. Abundant on some of the Keys at Florida, as at Sand Key in February, *W. H. H.* Later in the season it appears at Key West, *Dr. Blodgett*, &c. Conch Key, *Prof. M. Tuomey.* (v. v.)

Root densely coated and cushioned with woolly hairs. *Fronde* tufted, from two to five or six inches in height, cuneate at the base, rapidly expanding into a broadly fan-shaped lamina, whose upper margin forms constantly a circular arc. This lamina, which is at first simple, is at length, as the plant advances in growth, cloven into numerous lobes, by splits arising in some point of the margin and proceeding downward toward the base : each lobe, at first cuneate, soon becomes, by the rapid lateral development of its arched margin, fan-shaped like the primary frond. The whole fronds of young plants, and the several laciniae of older, are, when the plant is growing, rolled up in little conical or funnel-shaped cups. At distances of one or two lines, the frond is marked with concentric bands, more or less evident, according to age, along each of which is developed a fringe of extremely slender, orange coloured, jointed hairs. These hairs, which in young plants are found on every band, are limited on older specimens to the last formed bands, and at length disappear. The *margin* at the summit of the frond is always strongly rolled inwards ; the outer or lower surface of the lamina is whitened with a variable quantity of chalky powder ; the inner surface, except for the fringes of hairs, is smooth, olive-coloured, greenish towards the summit. The *sori* of fructification form concentric bands, alternating between the fringed bands. They are at first concealed beneath the surface-cells, but burst through in lines, raising the membranous skin of the frond, which then folds over them like the indusium of a fern. At maturity, the sorus consists of numerous obovate, hyaline perispores, fixed to a linear receptacle, each containing four sporules. *Paranemata*, club-shaped, articulated filaments, are found also in concentric bands, parallel to those which produce spores, and placed at short distances from them.

PLATE VII. B. *Fig. 1.* Plant of PADINA *Pavonia* ; the natural size ; *fig. 2*, part of the surface, showing portions of the band-like *sori* of *spores*, and of *paranemata* respectively ; *fig. 3*, vertical section of the frond, showing *spores* in situ ; *fig. 4*,

spores, each containing four sporules in the *perispore*; *fig. 5*, section through one of the concentric bands of paranemata; *fig. 6*, *paranemata*: the latter figures more or less highly *magnified*.

III. ZONARIA, Ag.

Root coated with woolly hairs. *Fron*d flat, ribless, coriaceo-membranaceous, flabelliform, entire or vertically cleft, the segments radiating; the surface cellules disposed in distinct longitudinal lines flabellately radiating from the base. Concentric lines indistinct. *Fructification* roundish or linear *sori*, formed beneath the cuticle of the frond, and bursting through at either surface; and composed at maturity, of *spores* furnished with hyaline perispores, and of *paranemata* which are mixed with the perispores. *Paranemata* club-shaped, articulated, numerous.

In the more or less fan-shaped frond this genus approaches *Padina*, but differs in the more opaque substance, only obscurely marked with concentric zones; and in the fructification, which is not disposed in regular, concentric lines. Here, too, the spores and paranemata occupy the same sorus, while in *Padina* they are separated. Under a pocket lens the surface appears to be finely striated longitudinally, an appearance caused by the disposition of the superficial cellules, which are ranged in lines proceeding from the base, slightly diverging one from another, and admitting the introduction of new series of cells between each original row, as the frond advances in growth. From this peculiarity results the fan-like form of the mature frond.

Ten or twelve species of this genus, from various parts of the world, are known to botanists. All are natives of the warmer parts of the sea, with the exception of *Z. parvula*, which by some authors is rejected from the genus.

1. *ZONARIA lobata*, Ag.; frond erect, coated with woolly hairs at the base only, membranaceo-coriaceous, broadly flabelliform, at first with a nearly entire margin, then palmately cloven, or divided nearly to the base; laciniae eventually elongate, wedge-shaped, simple or again divided, concentrically zoned; sori linear, formed along the concentric lines. *J. Ag. Sp. Alg. vol. 1, p. 109. Stypopodium fuliginosum, Kütz. Sp. Alg. p. 663. (TAB. VII. C.)*

HAB. On stones about low-water mark. Annual? Keys of Florida: abundant at Sand Key in February; and sparingly, at the same season, at Key West, *W. H. H. Sand Key, Prof. M. Tuomey. (v. v.)*

Root clothed with entangled and curled woolly hairs, which extend a short way from the base, covering from half an inch to an inch square of the lower part of the frond. The frond, which eventually becomes a foot or more in length and divided nearly to the base into many narrow lobes, originates in a sessile or nearly sessile, broadly reniform, membranaceo-coriaceous lamina. This lamina has at first a circumscribed margin, forming a somewhat cycloidal curve, and is nearly undivided. When it attains an inch or two in height, vertical slits, commencing in the margin, extend downwards, dividing it in a pedate or palmate manner, into a great number of narrow, wedge-shaped laciniae, placed side by side in digitate order. These, as they grow, become flabellate above, from the divergence of the rows of cells of which they are composed, and are again cleft and re-cleft, until often the originally reniform leaf becomes a bunch of narrow ribbons growing from a central point. In all these changes the apical margin remains truncate, and circumscribed by a curved line. It is perfectly flat, not inrolled. Radiating striæ, or inequalities in texture, proceeding from the base upwards towards each lobe, are more or less obvious in various specimens; and faint concentric lines, paler than the rest of the frond, are seen here and there crossing the lobes, at distances of a quarter to half an inch. These are more evident on older and more divided specimens, though they occur on the upper or newer portions of their fronds. The radiating longitudinal bands or striæ are sometimes very faint, and sometimes strongly marked. I have not seen *fructification* on any specimen collected at Sand Key.* The colour when growing is a dark olive, reflecting prismatic colours, chiefly vivid greens and blues, from the striated surface. In fresh water a good deal of dark colouring matter is given out; yet in drying the frond becomes exceedingly dark. In this state it adheres, but not very strongly, to paper, and shrinks very considerably.

Not having seen authentically named specimens of *Zonaria variegata*, Ag., it would be rash to say that that species may be only an undeveloped or small state of the present. Some of my Sand Key specimens are so remarkably striated, or marked with darker and paler longitudinal bands, and others so obscurely banded, and there are such insensible gradations between the banded and unbanded individuals, that I fear a character derived from these bands will not stand good. If *Z. variegata*, then, be distinguishable from our *Z. lobata*, it will probably be by a character taken from the different form of the sori, which are said to be "elliptical and scattered" in that species.

PLATE VII. C. *Fig. 1*, plant of *ZONARIA lobata*; the *natural* size: *fig. 2*, small portion of the summit of a segment, *magnified*, to show the surface cellules.

* The sori, on West Indian specimens, form dark lines at both sides of the pale, concentric band; but, besides these linear sori, others of irregular form are scattered between the bands.

IV. TAONIA, *J. Ag.*

Root coated with woolly hairs. *Frond* flat, ribless, vaguely cleft, reticulated ; the surface-cellules equally distant, in the apices of the laciniaë in parallel or subdivergent series. Concentric lines more or less evident. *Fructification* : linear, wavy, concentric, superficial *sori*, on both surfaces of the frond, destitute of indusium, and consisting of *spores*, furnished with hyaline perispores, and unaccompanied by paranemata.

This genus is formed for the reception of the old *Ulva atomaria*, Good. and Woodw., which has been variously referred to *Zonaria*, *Dictyota*, and *Padina*. To this typical species, whose character is chiefly embodied in the above generic diagnosis, Prof. Agardh has added, doubtfully, two other species, one of which falls within our limits. Perhaps it would have been better to have retained Kützinger's genus, *Spatoglossum*, for these two, whose relation to *T. Atomaria* is rather doubtful.

1. TAONIA? *Schroederi*, *J. Ag.* ; frond decompoundly cleft, irregularly dichotomous ; laciniaë broadly linear, toothed above, and bordered with marginal processes or lobules ; "antheridia ? scattered over the whole surface," (fructification unknown). *J. Ag. Sp. Alg. vol. 1, p. 102.* *Dictyota Schroederi*, Kütz. *Sp. Alg. p. 566.* *Aresch. Ic. t. 9.* *Ulva Schroederi*, Mart. *Fl. Braz. p. 21.* *Ic. Select. 1, t. 2, f. 3.*

HAB. At Vera Cruz, Mexico, *Liebman!* (v. s. in Herb. T.C.D.)

Frond rising from a shaggy base, ten to twelve inches in length, somewhat fan-shaped in the general outline of its laciniaë, irregularly dichotomous ; the principal laciniaë from half to three-quarters inch in breadth, the upper ones gradually narrower. In the lower part of the principal laciniaë the margin is either entire or obscurely denticulate ; in the upper half it is either strongly toothed, or the teeth lengthen out into linear or subulate, simple or slightly compound lobules. Sometimes the margin is flat, sometimes undulated or even curled. The apices are often irregularly jagged. The sinuses between the laciniaë are rounded, and the laciniaë themselves diverge at wide angles. The substance is thin and membranous, shrinking much in drying ; and the colour is a brownish or a greenish olive. No fructification has yet been observed, but the frond is commonly dotted over with minute, dark, prominent cells, which Agardh supposes may contain antheridia.

V. DICTYOTA. *Lamour.*

Root coated with woolly hairs. *Frond* flat, ribless, membranaceous, dichotomous or sub-pinnatifid, reticulated; the surface cellules minute, equidistant, converging at the ends of the laciniae and ending in a single cellule. Concentric lines none. *Fructification*; roundish, scattered *sori*, bursting through the cuticle of both surfaces of the frond, consisting at maturity of numerous obovate, tufted *spores*, with hyaline perispores. *Paranemata* in *sori* distinct from those containing spores, clavate, articulate, filled with grumous matter.

This genus, as recently reformed by Prof. J. Agardh, is easily known from any of the preceding by the mode of development of the frond, each of whose laciniae is seen to terminate in a single cellule, by the constant division of which at its lower side the other cells of the frond are formed, the terminal cell being thus continually pushed onwards. From this mode of growth it results that the longitudinal lines of superficial cells, which in the flabellate genera already described diverge from one another, in this converge: thus affording a ready method of ascertaining the genus in default of fructification.

1. DICTYOTA *Fasciola*, Lamour. (?); fronds densely tufted, very narrow, membranaceous, linear, many times dichotomous; axils obtuse; laciniae patent, very entire; apices acute; sori forming a medial line, and often accompanied by filiform processes. *J. Ag. Sp. Alg.* 1, p. 89. *Kütz. Sp. Alg.* p. 555. *Roth. Cat. Bot.* vol. 1, p. 7, f. 1. *Esp. Fuc. t.* 44. (?). (TAB. VIII. B.)

HAB. On rocks and stones, and corals near low-water mark. Annual. Abundant on the Florida Keys. Key West, Feb., *W. H. H.* (v. v.)

Fronds forming large and dense tufts, matted together at the base, six to ten inches in length, scarcely a line in breadth, of nearly equal breadth from the base to the apex, many times dichotomous. The axils are conspicuously rounded and the laciniae thus diverge one from another, particularly the upper ones. Sometimes the forking proceeds with equal arms throughout the tuft, and then the plant forms round, fastigate masses, the individual fronds not having any leading stem. In other specimens one arm of the fork, at alternate sides of the growing branch, is constantly shorter than the other; thus a frond with leading stems, bordered with short, simple or forked laciniae, is formed. The substance of the frond is membranaceous, thickish and subopaque below; the surface cells are about four times as long as broad; and the largish, hexagonal cells of the interior of the frond may be seen through the exterior cells in the younger parts at least. The apices are more or less acute, but not acuminate. The sori are disposed in a line through the centre of the lamina. Those formed of *paranemata* are most

abundant in my specimens, between which scattered spores are often found. In very many specimens the position of the sori is occupied by a line of proliferous papillæ or cilia of greater or less length.

I have some doubts whether I am correct in referring the Florida plant to *D. Fasciola*, Lam., to which, if it be different, it approaches very closely. I have compared it with Mediterranean specimens, but not with very well preserved or sufficiently developed ones; and the agreement in most respects is very great. But there is considerable difference in aspect among the Key West specimens, so much that at first I referred them to two species, in one of which the frond is fastigate, and regularly dichotomous; in the other, having more virgate branches, pinnatifido-dichotomous. On comparison of a great number of specimens, I do not find this difference in branching sufficiently constant. The figures of Roth and Esper, quoted above, are very rude. The present species is what was formerly doubtfully referred, on my authority, to *D. linearis*, Ag., and published by Prof. J. W. Bailey, as such, in his list of North American Algæ.

PLATE VIII. B. *Fig. 1*, Plant of *DICTYOTA Fasciola*; the *natural* size; *fig. 2*, portion of a segment, with *spores*, and tufts of *antheridia*; *fig. 3*, portion of a similar segment with papillæ; both *magnified*; *fig. 4*, small portion of a segment, with scattered *spores* and tufts of *paranemata*; showing also the surface cellules, and the lines defining the large internal cells; highly *magnified*.

2. *DICTYOTA dichotoma*, Lamour.; frond repeatedly dichotomous, broadly-linear, (1—4 lines broad) membranaceous; the axils narrow and subacute; laciniae erectopatent, gradually narrower towards the extremities; the margin entire; the apices obtuse or emarginato-crenate; sori and scattered spores dispersed over the medial region of the segments, leaving an unoccupied space within each margin. *J. Ag. Sp. Alg. vol. 1, p. 92. Harv. Phyc. Brit. t. 103. Ulva dichotoma, Huds.—E. Bot. t. 774. Dictyota vulgaris, and D. dichotoma, Kütz. Sp. Alg. p. 553, 554. Dichophyllum, Kütz. Phyc. Gen. p. 337.*

HAB. On stones and sea plants in tide pools. Rare. At Charleston, growing on old submerged wood-work at Sullivan's Island, *Prof. Lewis R. Gibbes*, Key West, *W. H. H. (v. v.)*

Fronds tufted, but not very densely clustered, from three to six inches long or more, varying much in breadth; ordinarily three or four lines in breadth, but sometimes much narrower and occasionally wider, several times dichotomous; the segments at each successive forking becoming narrower. In some varieties, the ultimate segments are very narrow and constantly spirally twisted; in the ordinary forms they are flat, and not much narrower than the lower ones. The axils are narrower than in the preceding species and the segments less widely spreading; and the apices are decidedly obtuse. The substance is thin and membranous, semi-

transparent, and the areolations visible with a moderately powerful pocket lens ; they vary in shape and in size in different parts of the membrane, and I fear scarcely afford a satisfactory specific character. I have not seen *fruit* on American specimens. On the European plant two sorts of fruit have been noticed, on different individuals : first, oval clusters of spores, covered at first by a common vesicular membrane ; each spore when ripe containing four sporules in a hyaline perispore ; second, solitary, roundish, simple spores scattered over the surface. The colour is olivaceous, sometimes greenish and sometimes brownish.

3. *DICTYOTA ciliata*, J. Ag. ; frond woolly at the base, repeatedly dichotomous, broadly linear, membranaceous ; the axils rounded ; laciniae patent, linear, gradually narrower towards the extremities ; the margin ciliate, with distant, awl-shaped, slender teeth ; the apices obtuse ; spores forming minute sori scattered over the middle region of the lamina, leaving an unoccupied space within each margin. *J. Ag. Symb.* 1. p. 5. *Sp. Alg. vol.* 1. p. 93. *Kütz. Sp. Alg.* p. 556. (TAB. VIII. A.)

HAB. On Algæ and corals near low-water mark. Florida Keys, abundant at Key West, *Dr. Wurdemann*, *Dr. Blodgett*, *W. H. H.*, &c. (v. v.).

Root and lower part of the frond coated with curled, woolly hairs. *Fron*ds densely tufted, six to eight or ten inches in length, from an eighth to a quarter-inch in breadth, many times dichotomous ; the laciniae gradually narrower in the upper dichotomies, ciliated at intervals of a few lines with slender, subulate, tooth-like processes. These are more abundant in some specimens than in others. The axils are rounded ; the lower ones spread widely and the upper are gradually narrower. The apices are subacute, or blunted. The *sori* consist of a few spores, irregularly grouped together, and scattered over three-fourths of the surface of the laciniae, leaving a narrow unoccupied portion down each margin. Sometimes the frond is pitted, (as shown at fig. 4,) the pits apparently caused by the falling off of the sori, carrying with them the surface cells. The colour is a clear brown olive, greener toward the tops ; and the substance is membranaceous, shrinking in drying. Readily known, in most cases, by the ciliate margins ; but sometimes nearly entire, in which case it may be mistaken for *D. dichotoma*.

PLATE VIII. A. *Fig.* 1. Plant of *DICTYOTA ciliata* ; the *natural* size ; *fig.* 2, part of a segment, with sori, and *fig.* 3, part of a segment from which the *spores* have fallen, leaving pits ; both *magnified* ; *fig.* 4, small portion of the surface, with *sorus*, showing the small surface cellules, and the lines defining the large internal cells : highly *magnified*.

4. *DICTYOTA Bartayresiana*, Lamour. ; frond scarcely woolly at the base, repeatedly dichotomous, linear, coriaceous-membranaceous, very entire ; the axils rounded ;

laciniae spreading, especially the upper ones ; apices divaricate, the younger ones sharply bifid, each lobe acuminate ; spores forming minute sori scattered over the whole surface of the lamina.—*J. Ag. Sp. Alg. vol. 1, p. 94. Kütz. Sp. Alg. p. 554. (TAB. VIII. C.)*

HAB. Tropical. Coast of Mexico, at Vera Cruz, *Liebman!* (v. s. in Herb. T.C.D.).

Frond three or four inches long, one or two lines in diameter, of nearly equal breadth throughout, many times dichotomously divided, with rounded axils and spreading segments. The uppermost divisions are more or less divaricated. The margin is entire and flat. The young apices are sharply notched or bifid ; each notch deltoid-acuminate, ending in a sharp point. The *sori* are minute and densely dotted over the whole surface. In our specimen they have fallen away, leaving cavities in their place. The substance of the frond is thickish, somewhat coriaceous, and the structure is denser than in some other species. The surface cellules are minute ; the areolations beneath them not much longer than their breadth. In drying, this plant does not adhere to paper. Known by its sharply bifid apices from any state of *D. fasciola* or *D. dichotoma*. Distinguished from *D. acutiloba* by the widely scattered fructification.

PLATE VIII. C. *Fig. 1*, Plant of *DICTYOTA Bartayresiana* ; the *natural size* ; *fig. 2*, apex of a segment, *magnified* ; *fig. 3*, extremity of the same, with depressions from which *sori* have fallen, and showing the surface cellules and internal cells ; highly *magnified*.

5. *DICTYOTA crenulata*, *J. Ag.* ; frond woolly at the base, repeatedly dichotomous, coriaceo-membranaceous, with patent, but not very blunt axils ; laciniae linear, undulate ; the margin eroso-dentate, the toothlets close together and of unequal size ; apices very blunt, lingulate ; sori at length occupying the whole surface. *J. Ag. Sp. Alg. vol. 1, p. 94. Kütz. Sp. Alg. p. 558.*

HAB. Tropical. At St. Augustin, on the Pacific coast of the Mexican Republic, *Liebman!* (v. s. in Herb. T. C. D.).

Fronds tufted, 2—4 inches high, about one and half or two lines in breadth, gradually wider from the base upwards, many times closely dichotomous ; the segments spreading, the whole frond having a fan-like outline. The sinuses between the laciniae are rounded, though not conspicuously so, and the upper ones are rather narrow. The margin is undulated, and closely eroso-denticulate, or jagged with unequal, deltoid, or subulate, tooth-like processes. The apices are rather wider than the portions below them, and so blunt as to be almost truncate. The young ones are obtusely emarginate. The sori are small, at first forming patches here and there, but eventually

occupying the whole superficies. The dentation of the margin is of the same nature as that of *D. ciliata*, but the teeth are very much closer and more irregular in form than in that species.

VI. STILOPHORA. *J. Ag.*

Root a small, naked disc. *Frond* cylindrical, branched, solid, or imperfectly tubular; composed of two strata of cells, the inner stratum of many rows of colourless cells, of which those nearest the centre become ruptured in age, leaving a cavity traversing the frond; the outer stratum of one or two rows of minute, coloured cells. *Fructification*, convex, wart-like *sori*, scattered over the branches, composed of obovate *spores*, nestling among moniliform, simple, densely packed *paranemata*.

The frond is described by Agardh as being at first tubular, but gradually becoming solid with advancing age. The contrary of this structure has always appeared to me to be the case, the older parts being more empty than the younger.

1. *STILOPHORA rhizodes*, *J. Ag.*; frond subsolid, much and irregularly branched, subdichotomous; the apices scarcely attenuate, acute; ramuli scattered, forked; sori densely covering the branches and ramuli. *J. Ag. Sp. Alg. vol. 1, p. 85. Harv. Phyc. Brit. t. 70. Spermatochnus rhizodes, Kütz. Sp. Alg. p. 549. (TAB. IX. B. .*

HAB. Near low-water mark, on other Algæ in tide pools. Rare. Newhaven, *Dr. Durkee*. Greenport, Long Island, *W. H. H.* Oyster Bay, N. Y. *Mr. Walters.* (v. v.)

Frond, in the American specimens, from four to five inches long, as thick as hog's bristle, much branched, irregularly dichotomous, with rounded axils. Branches flexuous, variously divided, furnished with a few lateral ramuli which are either simple or forked above their middle. The apices are acute, but not much tapered. The whole frond, in fertile specimens, is densely covered with the prominent, wart-like fructification; each wart composed of a great many moniliform vertical filaments, packed together. Among these the obovate spores are found lying, being attached to the bases of the filaments. The colour is a greenish olive; and the substance cartilaginous and elastic when fresh, but soon becoming soft and gelatinous, and in drying the branches shrink considerably and adhere strongly to paper.

PLATE IX. B. *Fig. 1.* Frond of *STILOPHORA rhizodes*, the *natural* size ; *fig. 2*, a small portion of a branch, with its wart-like sori, *magnified* ; *fig. 3*, section of a sorus, and of a portion of the frond ; *fig. 4*, a *spore* and *paranema* ; the latter figures highly *magnified*.

2. *STILOPHORA papillosa*, J. Ag. (?) ; frond cylindrical, many times dichotomous, with very patent angles and divaricating, attenuated apices ; the dichotomous branches and their lesser divisions clothed with very many slender horizontal, hair-like ramuli. *J. Ag. Sp. Alg. vol. 1, p. 84. (?)*

HAB. Chesapeake Bay, *Prof. J. W. Bailey.* (v. s.).

I am not satisfied that the plant from the Chesapeake, which I introduce more on my friend Prof. Bailey's authority than my own, is the same as the Mediterranean species described by Agardh ; nor, indeed, am I quite certain that it belongs to this genus. I have examined one of the original specimens, presented to me by Prof. Bailey, and had intended figuring it, but have not been able to make out the microscopical characters to my satisfaction. The above specific diagnosis applies very well to the specimen. But Meneghini's figure, (*Alg. Ital. t. 3, f. 2.*) quoted by Agardh for his species, is very unlike our plant. I have seen no authentic example of the Mediterranean *S. papillosa*, and thus am unable fully to decide on the identity of the American ; and, in this uncertainty, think it better to place the species on record, in the hope that future observation may clear the subject in one way or other. My specimen is about four inches square in the spread of the branches, and it scarcely adheres to the paper on which it has been dried.

VII. DICTYOSIPHON. *Grev.*

Root a small, naked disc. *Frond* filiform, tubular, much branched ; its walls composed of several rows of cells, of which the inner are elongated, and connected into longitudinal filamentous series ; the outer or superficial small, coloured, polygonal, forming a membrane. *Fructification* : solitary or aggregated, naked *spores*, scattered irregularly over the surface.

When young the frond is solid, but the cells forming the axis, which are of larger size than the rest, are also weaker and soon perish, leaving the stem and branches fistular. In a growing state every branch is clothed with long, slender, pellucid, jointed hairs, which give the plant, when seen under water, a beautifully feathery character. Similar hairs are seen on many others of the Order, and are doubtless connected with the development of the frond. The walls are composed

of many rows of elongated cells, disposed longitudinally and firmly united into a compact cellular substance. The innermost of these are very long, the outer proportionably shorter. All, except those that compose the outermost row or circle, are colourless, and nearly empty.

1. DICTYOSIPHON *feniculaceus*, Grev. ; frond setaceous, very much branched ; the branches capillary, decompound ; ramuli subulate, alternate or scattered, rarely opposite.—*J. Ag. Sp. Alg. vol. 1, p. 82.* *Kütz. Sp. Alg. p. 485.* *Harv. Phyc. Brit. t. 326.*

HAB. In rock pools, between tide-marks on stones and the smaller Algæ. Sea shores from New Brunswick to Long Island Sound. Prince Edward's Island, *Dr. Jeans.* Halifax, *W. H. H.* Boston Bay, *G. B. Emerson* and *Mrs. Asa Gray, &c.*, Rhode Island, *Mr. Geo. Hunt, Mr. Olney, &c.* Arctic Coast, *Mr. Seeman.* (v. v.)

Fronds from six inches to one or two feet long, about as thick, or sometimes twice as thick, as hog's-bristle, much branched and bushy ; usually having an undivided stem, set with many lateral branches, which are furnished with one or two series of lesser branches, also lateral, and very unequally and irregularly placed. *Primary* branches as long as the leading stem, or longer, very numerous. The spores are plentifully scattered over the branches, and are usually solitary. *Colour* a greenish or a brownish olive. *Substance* membranous, soft, but not gelatinous, adhering to paper in drying.

VIII. PUNCTARIA. *Grev.*

Root a small naked disc. *Frond* flat, ribless, membranaceous, undivided. *Fructification*, minute, dot-like *sori*, scattered over the whole surface, and containing roundish, sessile *spores*, accompanied by a few short, club-shaped, jointed *paranemata*.

The species comprising this group have the leaf-like habit of the smaller Laminariæ, such as *L. Fascia* ; or of the restricted genus *Ulva*, in which, by the older botanists, they would all have been placed. From Laminariæ they differ in being of a more reticulated structure, formed of larger cellules, and in the very different fructification ; and from the Ulvæ in colour as well as structure. To the genus *Asperococcus*, which immediately follows in order, *Punctaria* is very closely related, and only to be distinguished by the flattened, not tubular frond. But in *Asp. compressus* we find a strictly intermediate form, nearly as flat as a *Punctaria*, but evidently composed of two separable membranes.

1. *PUNCTARIA tenuissima*, Grev.; frond very thin, linear or linear-lanceolate, much attenuated to base and apex, flat or undulated. *Grev. Alg. Brit.* (1830) p. 54. *Harv. Phyc. Brit.* t. 248. *Punctaria undulata*, J. Ag. *Sp. Alg.* vol. 1, p. 72. *Diplostromium tenuissimum* et *D. undulatum*, Kütz. *Sp. Alg.* p. 483.

HAB. Parasitical on various Algæ near low-water mark; as *Zostera marina*, *Chorda filum*, &c. Annual. Spring and Summer.—Halifax, W. H. H. Boston Harbour, G. B. Emerson. Little Compton, R. I., Mr. Olney, and Prof. J. W. Bailey. Fort Hamilton, N. Y., Mr. Hooper, &c., W. H. H. (v. v.)

This forms dense tufts extending for several inches along the leaves of the *Zostera* or the fronds of the *Chorda* on which they grow. The fronds are from two to eight or ten inches in length, and from a line to four or five lines in width, broadest in the middle, and tapering to both extremities. Some specimens are nearly linear throughout, except at the base or apex where they fine off; but others are strictly lanceolate, very much attenuated from the middle towards the apex and the base. The margin in the young plant is quite flat; and often remotely, but irregularly denticulate. In older specimens the frond is undulated, or crisped and often twisted spirally. The membrane is very thin, semitransparent, and delicate; and the colour which is at first a pale greenish olive, becomes brownish or rather horn-colour in old plants. The fructification has not been observed.

I retain Dr. Greville's name for this plant, as being of earlier date than that assigned by Prof. J. Agardh; who rejects Dr. Greville's epithet from grounds which appear to me to be insufficient. The *Zonaria tenuissima* of the elder Agardh, which Dr. Greville takes as the type of his species, appears to have been founded (*Sp. Alg.* 1. p. 138, and *Syst. Alg.* p. 268) on *Ulva plantaginifolia* var. *tenuior*, *Lyngb. Hyd. Dan.*, p. 31, t. b.; and from Lyngbye's figure and description there can be little doubt that Lyngbye's and Greville's plants were identical in species. Nay, this is admitted by Prof. J. Agardh, who quotes both these authors under his *P. undulata*; but for some cause which I do not understand, he at the same time refers the synonym, "*Zonaria tenuissima*, Ag." to *Laminaria Fascia*. Yet, on referring to the *Syst. Alg.* where that name was first published, and from which Dr. Greville adopted it, we find the only synonym quoted is "*Ulva plantaginea* var. *tenuior*, *Lyngb. t. b.*" but with a mark of doubt. On referring back to Agardh's earlier work, the *Sp. Alg.* this same synonym is quoted without any doubt as the authority for Agardh's "*Zonaria plantaginea* var. *tenuior*," which is evidently the type of the subsequent "*Z. tenuissima*." Whether Agardh confounded young *Laminaria Fascia* also under this name is not to the point, as it is evident from his description and quotation that he intended by the name "*tenuissima*," the "*U. plantaginifolia* var. *tenuior*" of Lyngbye; and that is also the plant intended by Dr. Greville, and here described. I see no reason therefore for changing the older and very appropriate specific name into "*undulata*."

2. *PUNCTARIA plantaginea*, Grev.; frond dark brown, coriaceous-membranaceous,

obovate, much attenuated at the base. *Harv. Phyc. Brit. t. 228. J. Ag. Sp. Alg. vol. 1, p. 73. Phycolapathum plantagineum, Kütz. Sp. Alg. p. 483.*

HAB. On stones and Algæ between tide-marks. Annual. Summer. Prince Edward's Island, *Dr. Jeans.* Boston Harbour, *G. B. Emerson, Esq. (v. v.)*

Tufted. *Fronde*s from 6 to 12 inches long, an inch to an inch and half in breadth in the widest part, generally blunt, obovate or cuneate, tapering considerably to the base from near the middle of the membrane. The substance is thicker and more coriaceous than in *P. latifolia* and the colour always darker. But specimens occur which are almost intermediate in character between the two. There is also danger of confounding *P. plantaginea* with *Laminaria Fascia*, which has a very similar appearance.

PUNCTARIA *latifolia*, Grev. ; frond pale olive green, thickish, membranaceous, soft and tender, oblong or obovate, suddenly tapering at the base. *Harv. Phyc. Brit., t. 8. J. Ag. Sp. Alg. vol. 1, p. 73. Phycolapathum debile, Kütz. Sp. Alg. 483.*

HAB. On stones and Algæ between tide-marks. Annual. Summer. Halifax, *W. H. H.* Boston Harbour, *G. B. Emerson.* Flushing Bay, Long Island, *Prof. J. W. Bailey and Mr. Hooper.* Fort Hamilton, N. Y. *Mr. Hooper, &c. (v. v.)*

Tufted. *Fronde*s eight to twelve inches long, and from one to three inches wide in the broadest part, oblong or obovate, or somewhat ovate, generally obtuse, and suddenly tapering at the base into a short cuneate stem, a line or two in length. The margin is undulate, sometimes much crisped and curled. The substance is thin, membranaceous, soft, and almost gelatinous to the touch when young, at which time it is clothed with pellucid hairs ; afterwards it is more rigid, and at length so coarse that it will not adhere to paper when drying. The colour, when young, is an extremely pale olive, inclining to green, and specimens are often found that retain this colour at their full size, but now and then others accompany them in which the colour is much darker. These approach *P. plantaginea*, and are then only to be known by the less tapering base. I retain the three species as published by Greville, though I admit that it is sometimes difficult to distinguish between them in every case. There are *three* principal typical forms, and a number of intermediate links. The present is much the commonest on the American shore, and after it that called *P. tenuissima*. I shall not be surprised if future botanists, when the rage for species-making has exhausted itself, and the tide sets in an opposite direction, shall re-unite these three under the old name *plantaginea*.

IX. SORANTHERA, *Post. and Rupr.*

"*Fronde* membranaceous, olive-green, simple, flat, dilated, entire. *Fructification* : *Antheridia* pear-shaped, vaginate, mixed with club-shaped jointed threads, and aggregated in roundish sori scattered over the whole frond."

1. SORANTHERA *ulvoidea*, Post. and Rupr. Illustr. p. 19. *J. Ag. Sp. Alg.* vol. 1, p. 120. *Kütz. Sp. Alg.* p. 556.

HAB. Island of Sitcha, Russian America, parasitical on *Rhodomela larix*. (*Postells and Ruprecht*).

"Lamina membranaceous, olive-green, sub-rotund, plaited, in the two specimens seen not more than an inch in breadth ; the margin very entire, not thickened, nor distinctly revolute. The whole lamina so densely covered with roundish tubercles, a quarter of a line in diameter, and prominent on both surfaces, that scarcely any interstitial spaces of more than a line in breadth remain sterile. The tubercles are composed of an assemblage of heterogeneous antheridia, and considered as sori ; in the dry state they collapse and become harder and brown. The dried lamina is thinly membranous, scarcely loses colour, and does not adhere to paper."—*Post. and Rupr.* Of this plant I know nothing. It seems, to judge by the above description, to be related to *Punctaria*, if distinguishable from that genus.

X. ASPEROCOCCUS, *Lamour.*

Root a small, naked disc. *Fronde* tubular, cylindrical or inflated, rarely compressed, membranaceous, unbranched and inarticulate. *Fructification* minute, dot-like sori, scattered over the whole surface, and containing roundish, sessile spores, accompanied by a few short, club-shaped, jointed paranemata.

This genus differs from *Punctaria* in having a tubular or inflated, instead of a flat frond. *Asperococcus sinuosus* departs in habit from the typical species, but seems to be identical in structure or nearly so. *A. clathratus* of authors is, in my opinion, *sui generis*.

1. ASPEROCOCCUS *echinatus*, Grev. ; frond cylindrical, club-shaped, obtuse, much attenuated at the base. *Harv. Phyc. Brit. t.* 194. *Grev. Crypt. Fl. t.* 290. *J. Ag. Sp. Alg.* vol. 1. p. 76. *Encœlium echinatum*, Ag.—*Kütz. Sp. Alg.* p. 552.

HAB. Rocks, &c. between tide-marks. Annual. Boston Bay, *G. B. Emerson* (fide Prof. J. W. Bailey.) (v. v.)

Very variable in size. *Fronds* from a few inches to two feet in length, and from the thickness of hog's-bristle to half an inch in diameter, linear-club-shaped, tapering to the base. The apex is either obtuse, or somewhat attenuated. The dots of fructification are crowded, and often entirely cover the surface.

I have not seen American specimens, but give this species on the authority of my friend Prof. Bailey, merely remarking that *Chorda lomentaria* is often mistaken for it, and has been sent to me from America for the *Asperococcus*. The true *A. echinatus* is however so common in the Northern Atlantic, that it is most probably to be found on many parts of the American coast. It may be known from *Ch. lomentaria* by being never constricted into joints.

2. *ASPEROCOCCUS sinuosus*, Bory ; fronds globose, or irregular, heaped together, sessile, inflated, at length irregularly distorted and torn. *J. Ag. Sp. Alg. vol. 1. p. 75. Encœlium sinuosum, Ag.—Kütz. Sp. Alg. p. 552. (TAB. IX. C.)*

HAB. On rocks, corals and Algæ between tide-marks. On the Florida Keys. Very abundant at Sand Key, and washed ashore at Key West, *W. H. H.* (v. v.)

Fronds growing in dense clusters which cover spaces of many inches or some feet square. Each individual frond is globose, one or two inches in diameter, or larger, becoming much inflated and irregular in outline as it advances in age, and is then often ruptured, and pierced here and there with holes of irregular shape and size. The frond is membranous, thin, soft, but not very tender, having a reticulated appearance, from the large interior cells composing the inner lining of the membrane ; and with a smooth uniform surface, from the minute cells which compose the superficial coating : it thus follows that with lenses of different powers the frond appears either areolated or of densely cellular structure. Such *fructification* (?) as I have seen consists in minute *sori*, dotting over the surface, and composed of linear, moniliform *paranemata*, formed at first under the membranous coating of the frond, and bursting through it :—but I have not detected any *spores*. *Colour* a brownish olive.

In habit this plant strongly resembles *Leathesia tuberiformis* (common on the shores of the Northern States) but is of a totally different structure, and can only be confounded with that plant through carelessness or inattention

PLATE IX. C. *Fig. 1.* Cluster of *ASPEROCOCCUS sinuosus* ; the *natural* size ; *fig. 2,* a minute portion of the surface ; *fig. 3,* vertical section of a sorus ; *fig. 4,* *paranemata* from the same ; the latter figures highly *magnified*.

SPECIES OF DOUBTFUL AFFINITY.

3. *ASPEROCOCCUS intricatus*, J. Ag., "frond tubular, branched, sub-hemispherically expanded, subrepent; branches intricate, gradually attenuated, decompound-dichotomous; the apices forked." *J. Ag. Sp. Alg. vol. 1, p. 77.*

HAB. Tropical. At Vera Cruz, Mexico. (*Liebman*).

I am not acquainted with this plant, which scarcely seems to fall naturally under this genus.

XI. HYDROCLATHRUS, *Bory*.

Frond membranaceous, convex, hemispherical, bag-shaped, regularly pierced with orbicular holes, which gradually dilate more and more, until the plant becomes a clathrate net, eventually mishapen and ruptured. *Margin* of the apertures involute. "Spores minute, globose, collected into dot-like, scattered, innate *sori*, accompanied by club-shaped, jointed filaments." (*Mont.*)

This is a very remarkable plant, and of so peculiar a habit, as well as distinct structure, that I can hardly imagine any person who has had an opportunity of seeing it alive on its native rocks, placing it in the same genus with *Asperococcus sinuosus*; although my valued friend Prof. J. Agardh even doubts its specific diversity from that species. I must suppose that Prof. Agardh has formed his judgment from an examination of dried specimens, which are so wholly unlike the living plant in appearance, and can be so imperfectly examined when remoistened, that a satisfactory opinion can scarcely be formed from them. I regret that the microscope which I had with me at Key West was not of sufficient power to enable me to make out the anatomical structure perfectly, and the plant decomposed so rapidly that it was difficult to obtain good slices of the membrane sufficiently thin for examination. When fresh from the sea, the frond was quite crisp, and could readily have been cut, but my specimens (collected at Sand Key) had to be brought a long way in an open boat, under a hot sun; and although every care was taken to keep them cool, and though they were brought in buckets of water, decomposition had commenced long before they reached Key West, and then, in the attempt to save from destruction a large gathering of other Algæ, the fruit of the same excursion, only very imperfect notes could be made on the present curious plant. Such sections as I was able to make through the membrane showed me that it was composed of several rows of cells; the inner rows, occupying almost the whole thickness, being formed of large, colourless cells, filled with fluid, distended,

and having thin walls. The outer stratum in which the colour resides is very thin, composed of exceedingly minute cells, with square ends, but whose exact shape I could not well determine. Dr. Montagne, in his splendid work on Algerian Algæ, says that they are parallelipipeds, placed, with their smaller ends to the circumference. With the views respecting this species entertained by Dr. Montagne and expressed in that work I fully concur, and now proceed to describe this curious vegetable in detail.

1. *HYDROCLATHRUS cancellatus*, Bory.—*Mont. Alg. Algier. p. 36. Asperococcus clathratus, J. Ag. Sp. Alg., vol. 1, p. 75. Encœlium clathratum, Ag.—Kütz. Sp. Alg. p. 552. Halodictyon cancellatum, Kütz. Phyc. Gen. p. 338. (TAB. IX. A.)*

HAB. Subtropical. On rocks, etc., in tide pools near low-water mark. Annual. Sand Key, Florida, abundant in February. *W. H. H. (v. v.)*

Fronds of irregular form, oblong or sinuous, two to three inches in length and about an inch high, heaped together in wide-spreading patches, adhering to the rocks by the lower surface, and to each other by their sides. The young fronds, in the earliest stage at which they were found, are pierced by rounded holes, of small size and somewhat pressed together. As the membrane expands, the original holes expand also, and grow wider, and new holes are formed in the interspaces, until the whole membranous wall of the bag-like body is converted into a delicate, lace-like network. The *margin* round each hole is strongly involute, which gives the appearance of a thickened rim, when the membrane is viewed vertically. The substance is thick, crisp to the touch at first, but very fragile, and it soon changes colour and loses rigidity on exposure to the air. The surface-cells are exceedingly minute, filled with colouring matter; those that compose the thickness of the membrane are of large size, hexagonal, with thin walls and full of watery juice. No fructification was observed on my specimens. The colour when growing was a very pale, yellowish-olive, somewhat ochraceous. This rapidly changes, and the plant becomes dark brown in a dried state.

Our figure gives a tolerable idea of the Sand Key plant, as to size of individual fronds and mode of composition of the patches: but I have failed in making it sufficiently lace-like, and in giving the effect of depth to the holes which pierce it in every direction. I have some doubts whether all the plants known under the name *H. cancellatus* are identical. The beautiful figure in the great French work on Egypt, would not at all answer any specimen of the Sand Key plant which fell under my notice. But it must be borne in mind that my specimens were gathered early in the season, and were comparatively young; and, therefore, it is possible that later in the year they might have put on a very different aspect. If all the clathrate Algæ referred to this place by botanists belong to the present species, it has a wide range; being found through the warmer parts of the Atlantic at both sides; in the Mediterranean; the Red Sea; on the shores of the Mauritius, and

of those of New Holland. It would be difficult to determine from dried specimens whether the specimens from these various places were identical or not. The living plant has the aspect of a very open sponge, and is so frail that it cannot be raised from the rocks without laceration, and so weak that it cannot support its own weight when lifted from the water.

PLATE IX. A. *Fig. 1.* Several fronds of *HYDROCLATHRUS cancellatus*, growing together, the *natural* size; *fig. 2*, a portion of the perforated frond, *magnified*; *fig. 3*, minute piece of the same, showing the surface-cellules, *highly magnified*.

ORDER V. CHORDARIACEÆ.

CHORDARIÆ, *Harv. in Mack. Fl. Hib. part 3, p. 183. Harv. Man. Br. Alg. Ed. 1, p. 45. Ed. 2, p. 44. J. Ag. Sp. Alg. vol. 1, p. 45. CHORDARIÆ, (excl. gen.) J. Ag. Alg. Medit. p. 31. Endl. 3rd, Suppl. p. 23. Dne. Ess. p. 33. MESOGLOIACEÆ, Kütz. Phyc. Gen. p. 329. Sp. Alg. p. 539. CHORDARIDÆ (excl. gen.) Lindl. Veg. Kingd. p. 22.*

DIAGNOSIS. Olive-coloured seaweeds, with a gelatinous or cartilaginous frond composed of vertical and horizontal filaments (or strings of cells) interlaced together. *Spores* attached to the filaments, and concealed within the substance of the frond.

NATURAL CHARACTER. *Root* rarely more than a disc of attachment; in the more perfect kinds it forms a point of fixture, at the base of the stem; in the less perfect, the whole under-surface of an expanded frond adheres to the object on which the plant grows. *Frond* very variable in form, but in all cases composed of articulated threads or cells strung together in vertical and horizontal series, variously combined among themselves, but easily separable under the microscope, and either accompanied by mucus or lying in a transparent gelatine. The gelatine varies both in quantity and in degree of tenacity. When little developed, it is also more tenacious, and then the fronds are firmly cartilaginous, or somewhat coriaceous, and highly elastic. But more generally the gelatine is abundant in quantity and very loose in substance, and then the threads composing the frond lie considerably apart one from another, and the common substance becomes soft and gelatinous. The least organised plant of the order (*Ralfsia*) has a crust-like frond spreading over the surface of rocks, like one of the *Lichens*, in circular or oblong patches, and bearing on its surface small prominences which eventually contain *spores*, mixed with *paranemata*. Next in development is *Leathesia*, whose frond is either a shapeless or lobed roundish mass, or a cluster of such growing together like so

many small potatoes. This genus, lumpy as it is, is closely allied in structure to *Mesogloia*, from which it is chiefly distinguished by the shapeless frond. The frond in the latter group is branching, with a pinnate habit. A further advance in structure is made in *Chordaria*, where the axis becomes very compact; and in *Scytothamnus*, a genus found at New Zealand, the frond attains its maximum of structure. In that group the substance is as tough and leathery as it is among the *Fucaceæ*, yet an appeal to the microscope shows a filamentous structure not essentially differing from that found in *Chordaria* or *Mesogloia*. The genera *Elachista* and *Myrionema* are a little different in structure from the other genera of the order, and indicate a passage into *Ectocarpaceæ*. In them some of the filaments composing the frond are free, or not enclosed in gelatine; but as the spores are lodged among the filaments which are compacted together into the base of the fronds, I prefer retaining these genera in the present order. By Prof. J. Agardh, *Elachista* is referred to *Ectocarpaceæ*, and *Myrionema* retained in *Chordariaceæ*, but both are so closely allied to each other, and also to *Leathesia*, that I am unwilling to separate them.

The spores of the *Chordariaceæ* are very generally obovate, obtuse at the apex and narrowed to the base, and in many they taper so considerably as to become almost club-shaped. They are enclosed in pellucid perispores, and attached to some portion of the filamentous structure of the frond, generally to the filaments forming the *periphery* or outer stratum. They are usually accompanied by paranemata. In *Ralfsia* alone they form prominent, wart-like *sori*, not unlike those of *Stilophora* among *Dictyotaceæ*. The colour of the frond varies from a greenish to a brownish olive, and is sometimes very dark. It is not much altered in drying.

About forty-five species of this Order have been described from various parts of the world. The majority are natives of the colder portion of the temperate zone, both north and south; and some species, such as *Leathesia tuberiformis* and *Chordaria flagelliformis*, are equally common in the Northern and Southern Hemispheres.

I have found the gelatine of *Chordaria flagelliformis*, extracted by allowing the fronds to remain a day or two in fresh water, useful in causing small Algæ, which are not of themselves sufficiently gelatinous, to adhere to paper. It is however too weak for any except very slender kinds. With this exception, none of the species are used in the arts.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

* *Frond cylindrical, branching.*

- I. CHORDARIA. *Axis* cartilaginous, dense, solid (at length hollow in the centre)
Filaments of the periphery unbranched.

II. MESOGLOIA. *Axis* gelatinous, laxer in the centre, composed of a network of filaments. *Filaments* of the periphery branched.

III. LIEBMANNIA. *Axis* gelatinous, denser in the centre, composed of longitudinal, approximated filaments. *Filaments* of the periphery forked.

** *Frond* either tuber-shaped or crust-like.

IV. LEATHESIA. *Frond* tuber-shaped, cartilagineo-gelatinous.

V. RALESIA. *Frond* crust-like, spreading in round patches.

*** *Parasites*, consisting of densely tufted filaments, connected at the base, and free above.

VI. ELACHISTA. *Filaments* pencilled, rising from a common tubercle composed of vertical fibres.

VII. MYRIONEMA. *Filaments* pulvinate, rising from a flat base composed of decumbent fibres.

I. CHORDARIA. Ag.

Frond cylindrical, branched, cartilaginous, solid, at length hollow in the centre, coated with a pile of radiating, horizontal, peripheric filaments. *Axis* formed of oblong cells, connected by their ends into anastomosing, longitudinal filaments, forming a compact network. Filaments of the *periphery* at first deficient, gradually evolved, and at length coating the axis in a continuous pile, densely set, club-shaped, simple, moniliform, composed of spherical cells. *Spores* clavate or obovate, arising from the base of the radiating peripheric filaments, and concealed among them.

It is stated by Prof. J. Agardh that the axis of the frond is at first hollow, and that it gradually becomes solid in age, from the tube being filled up with cells. I find the reverse of this to be the case. In carefully made cross sections of the young frond of *Ch. flagelliformis* taken when the plant is an inch or two in height, and long before the evolution of the peripheric filaments, I find the axis quite as solid as at more advanced periods; and I also find in old plants, but more especially in *Ch. divaricata*, that the central cells of the axis disappear in old age, leaving the frond quite fistular. This also takes place in *Mesogloia*, particularly in *M. vermicularis*. In *Ch. divaricata* this hollowing of the frond of old specimens is very obvious.

1. CHORDARIA *flagelliformis*, Ag.; stem subsimple, densely set with long, lateral, filiform, simple branches, which are either naked or sparingly furnished with ramuli;

filaments of the periphery club-shaped. *J. Ag. Sp. Alg. vol. 1, p. 66. Kütz. Sp. Alg. p. 546. Harv. Phyc. Brit. t. 111. Fucus flagelliformis, Turn. Hist. t. 85. E. Bot. t. 1222.*

HAB. On rocks, stones, and the smaller Algæ between tide-marks. Common on the shores of the Northern States. Newfoundland, *Lenormand*. Halifax, *W. H. H. Newport, R. I., Prof. Bailey, Mr. Olney, &c. Boston, G. B. Emerson. Staten Island, N. Y. (v. v.)*

Fronde 1—2 feet long, as thick as bristle, mostly with an undivided leading stem, which is densely set throughout its whole length with crowded or fasciculate lateral branches. These branches are several inches long, of the same thickness as the stem, straight or nearly so, and usually unbranched and quite naked: sometimes they have each a few distant, spreading, straight ramuli; and sometimes they are as densely beset as the stem with such ramuli. The substance is firmly cartilaginous and elastic, the surface lubricous, and if the plant be allowed to remain some hours in fresh water, a very considerable quantity of mucus and some colouring matter will be given off. The colour is always very dark olivaceous brown. In young specimens, the whole frond consists of the cellulo-fibrous axis, composed of a dense network of anastomosing threads; there is then no *periphery*, or merely an outward coating of dark-coloured cells. As the plant enlarges, the surface-cells grow out, by repeated cell-division, into moniliform peripheric threads, which form a complete covering or pile to the frond. These peripheric filaments are club-shaped, the cells of which they are composed gradually increasing in size, from the base to the apex of the filament. *Spores*, concealed among the threads of the periphery, are abundantly produced by almost every full-sized individual. When growing, the whole frond is clothed with fine, colourless, jointed hairs, which give the branches, as seen through the water, a feathery appearance.

2. CHORDARIA *divaricata*, Ag.; frond irregularly divided; branches divaricating, subdichotomous, flexuous, furnished with scattered, short, very patent, mostly forked ramuli; filaments of the periphery capitate. *J. Ag. Sp. Alg. vol. 1, p. 65. Harv. Phyc. Brit. t. 17. Mesogloia divaricata, Kütz. Sp. Alg. p. 545. (TAB. XI. A.)*

HAB. On the smaller Algæ, etc., at and below low-water mark. Shores of Long Island Sound, Stonington, *Prof. J. W. Bailey. Newport, R. I., Mr. S. T. Olney. Dr. Durkee. Green Port, Long Island, Prof. J. W. Bailey and W. H. H. New Bedford, Mr. Congdon. (v. v.)*

Fronde tufted, one or two feet long or more, not a line in diameter, very much, but irregularly branched. Sometimes there is a leading stem, with lateral branches, and sometimes the frond is broken up from the base into many principal divisions. The branches are of various lengths, subsimple or repeatedly forked. They spread at wide angles, and their divisions are equally patent, the intermediate spaces being

curved or flexuous. In some specimens these forked branches are quite naked ; in others furnished with patent simple or forked ramuli from half an inch to an inch in length ; and in others beset with a multitude of such ramuli, or of more compound ones. In these last the frond becomes excessively branched, with all its divisions divaricated and beset with irregular branchlets. When young, the axis is solid, firmly cartilaginous and cellular, but with advancing age the central cells die out, and the stems and branches become fistular, or even somewhat inflated. Such specimens also lose much of their original lubricity, and may readily be mistaken for a different species—or even for a *Stilophora*, if care be not taken to observe the filaments of the periphery. These filaments afford a tolerably definite specific character in being slender, with a large terminal cell ; but in individuals of different ages the size of the terminal cell varies considerably. The colour is a greenish olive, paler than in the former species, but becomes dark brown in old age and in drying, in which latter state the plant adheres to paper and shrinks very considerably.

PLATE XI. A. Frond of *CHORDARIA divaricata*, the *natural* size ; *fig. 2*, cross section of a young branch ; and *fig. 3*, the same of an older branch, both equally *magnified* ; *fig. 4*, a spore and two peripheric filaments, *highly magnified*.

II. MESOGLOIA, *Ag.*

Frond cylindrical, branched, cartilagineo-gelatinous, solid, at length partially hollow in the centre, coated with a pile of radiating, horizontal, branched peripheric filaments. *Axis* composed of longitudinal, articulated, anastomosing filaments, connected together into a network, which is laxer toward the centre ; the cells of the inner filaments long, those of the outer shorter. Filaments of the *periphery* rising from the outer layer of axial filaments, moniliform, composed of ellipsoidal cells, fasciculate, frequently dichotomous. *Spores* obovoid, attached to the base of the peripheric filaments, and concealed among them.

Plants with the habit and much of the structure of *Chordaria*, but of a more gelatinous substance and looser texture. In this group I propose to include *Myriocladia* of J. Agardh, the structure of which does not appear to me to be essentially different from that of ordinary *Mesogloia*, while the external habit is so similar that even the specific diversity of the species of *Myriocladia* from species referred by Agardh to *Mesogloia* is variously held by different authors. Careful analyses of recent specimens in various stages have still to be made ; for though these plants can be tolerably well observed in a dried state, it is not easy in that state to isolate the filaments of the axis so as to show the structure perfectly. For

this reason, among others, I prefer retaining *Mesogloia Zosteræ*, Aresch. and *M. Lovenii*, J. Ag. in the same genus as *M. virescens*.

1. *MESOGLOIA vermicularis*, Ag. ; frond clumsy ; branches irregularly pinnate, thick, worm-like, linear-fusiform ; ramuli copious, long, flexuous, resembling the branches ; filaments of the periphery moniliform, clavate, with spheroidal cells. *J. Ag. Sp. Alg. vol. 1, p. 58.* *Kütz. Sp. Alg. p. 544.* *Harv. Phyc. Brit. t. 31. E. Bot. t. 1818.*

HAB. On stones and Algæ between tide-marks. Annual. Halifax, W. H. H. (v. v.)

Frond a foot or more in length, with a subsimple leading stem set with lateral branches, which are either simple and naked, or furnished with secondary, worm-like branchlets. The principal divisions are two or three lines in diameter, irregularly swollen here and there, often contracted at the base, curved or flexuous, and taper to a bluntish point. The filaments of the periphery are densely set, shorter than the diameter of the branches, and rise from the inflated, colourless, external cells of dichotomous intra-peripheral filaments, which branch off from the longitudinal filaments composing the axis. The peripheric filaments are coloured, tufted, clavate, and bear *spores* in the centre of the tuft. In old age the stem and branches become hollow, and the substance less gelatinous. This takes place most frequently when the plant grows in deep water, beyond the influence of the tide. The colour is a brownish olive.

I collected only a single specimen of this plant at Halifax.

2. *MESOGLOIA virescens*, Carm. ; frond filiform, gelatinous ; branches long, erecto-patent, slender, villous ; ramuli more or less numerous, very patent, short, obtuse ; filaments of the periphery as long as the diameter of the axis, dense, moniliform, with spheroidal cells rather longer than their breadth. *J. Ag. Sp. Alg. vol. 1, p. 56.* *Harv. Phyc. Brit. t. 81.* *Kütz. Sp. Alg. p. 545.* (TAB. X. B.).

HAB. On *Zostera* at Nahant, Massachussetts, Miss E. H. Brewer. On small Algæ at Sand Key, Florida, W. H. H.

Frond in the American specimens already seen, which are not of full size, two to three inches long, in full grown (European) specimens 8—12 inches or more, slender, branched in a pinnated or irregular manner, usually with a leading undivided stem, set with patent, lateral branches. Branches horizontal or widely spreading, short, or more generally elongated, filiform, of nearly equal diameter throughout, appearing villous to the naked eye from the length and projection of the peripheric filaments. Secondary branches resembling the primary, but shorter, increasing in number with the age of the specimen. The peripheric filaments are

beautifully beaded; more slender and much longer than in *M. vermicularis*; but shorter, and with more globose joints than in *M. Zosteræ*. The colour is an olivaceous green, becoming rather greener after the specimen has been dried. The substance is very soft and gelatinous.

My figure is taken from one of the Sand Key specimens. These are less villous, owing to youth, than most specimens of the species, and have more the aspect of *M. Griffithsiana*, but on a close microscopic examination they appear to have all the characters proper to *M. virescens*. Miss Brewer's specimens are still younger, but, though growing on *Zostera*, appear to belong to *virescens* and not to the following.

PLATE X. B. *fig. 1.* Fronds of *MESOGLOIA virescens*, the natural size; *fig. 2.* small portion of a branch, *magnified*; *fig. 3.* peripheric filaments, attached to the axial; *fig. 4.* a peripheric filament removed, the latter figures *highly magnified*.

3. *MESOGLOIA Zosteræ*, Aresch. (?); frond filiform, gelatinous, flexuous, slightly branched; branches very short and subsimple, distant, villous, patent, with rounded angles; filaments of the periphery much longer than the diameter of the axis, lax, submoniliform, with ellipsoidal cells, twice as long as their diameter. *Mesogloia Zosteræ*, ?; Aresch. *Pug. t. 8, f. 1, a. 6.* *Myriocladia Zosteræ* ? or *M. Lovenii* ? *J. Ag. Sp. Alg. vol. 1, p. 53.* (TAB. X. A.).

HAB. On *Zostera* in deep water. Annual. Halifax, W. H. H.

Fronds 6–8 inches long, very slender, filiform, flexuous or angularly bent, either without lateral branches, or furnished at distant intervals with a few very short, patent, or divaricating, simple or forked ramuli, from a line to an inch in length, but seldom longer. These branchlets issue at very wide angles, and sometimes at the point where they arise the main stem takes a bend in the opposite direction, as if the proper mode of branching were dichotomous, but that one of the forks were perpetually aborted into a ramulus. The peripheric filaments are much longer than the diameter of the axis which they clothe, and are laxly set, surrounded by a loose jelly. They are dichotomous, and spring from slender longitudinal filaments coating the internal filaments of the axis, but which I have failed to detect anastomosing into a net work, as described by J. Agardh (if we are really speaking of the same plant). The articulations of the radiating filaments are fully twice as long as broad, and but slightly contracted at the dissepiments. The colour in my specimens is a yellowish olive.

Few plants have been more confused by authors than the *Linckia Zosteræ* of Lyngh., *Mesogloia Zosteræ*, Aresch.; and I hope I am not farther confusing synonyms by referring to this place the plant now described and figured. Lynghye's figure is certainly very unlike my plant, and is referred by J. Agardh to the young of *Mesogloia virescens*, which it much more nearly resembles. But Areschoug, whose figure accords more nearly with that now given than with the previous figure of Lynghye, has examined a specimen of Lynghye's plant, and declares it

the same as his own. J. Agardh, taking up Areschoug's *M. Zosteræ*, as identical with his own *Myriocladia Zosteræ*, states that the cells of the peripheric filaments are subspherical; and describes a new species, *M. Lovenii*, in which they are twice as long as broad. In my specimens now described I find the peripheric cells of the length attributed to those of *M. Lovenii*, and yet I hesitate whether to refer them to that species. I have not seen any authentic specimen of either Agardh's or Areschoug's plant, and must leave the final determination of the difficulty to those who have such specimens to compare.

PLATE X. A. *Fig. 1.* Fronds of *MESOGLOIA Zosteræ*, growing on *Zostera marina*, the *natural* size; *fig. 2*, small portion of a branch, *magnified*; *fig. 3*, some of the axial and peripheric filaments of the same; *fig. 4*, portion of one of the peripheric filaments; the latter figures highly *magnified*.

III. LIEBMANNIA. *J. Ag.*

"*Frond* cylindrical, branched, filamentous, solid, clothed with radiating peripheric filaments. *Axis* composed of oblong, approximated cells, cohering in longitudinal filaments; the filaments toward the centre narrower, and there collected into a peculiar dense stratum. Peripheric filaments arising from the outermost axial cells, mucous, moniliform, forked. *Spores* obovoid, seated in the axils of the radiant filaments, girt with a hyaline perispore. *Propagula* at the apex of the radiating fibres lancicoid, one, two or four, sessile within a hyaline, inflated, obpyriform perispore, sub-articulate-constricted, and longitudinally divided."—*J. Ag.*

LIEBMANNIA *Leveillei*, *J. Ag. Alg. Medit. p. 35. Sp. Alg. vol. 1, p. 61. Mesogloia Leveillei, Menegh. Alg. Ital. p. 283, b. 5, t. 2.*

HAB. Parasitical on *Zostera*. At Vera Cruz., Mexico, *Liebman*. (v. s. in Herb. T.C.D.)

I give the characters of this genus as nearly as possible in Prof. J. Agardh's words. I have not seen an American specimen, but possess an Adriatic one from Prof. Meneghini. This has the outward characters of *Mesogloia vermicularis*.

IV. LEATHESIA. *S. F. Gray.*

Frond globose or lobed, solid or at length hollow, consisting of filaments radiating to all sides from a central point. *Axis* composed of oblong colourless cells, united in dichotomous threads which issue from a common base ; the uppermost cells half-moon shaped. *Peripheric* filaments issuing from the outermost axial cells, simple, moniliform, strongly glued together, with globose articulations. *Spores* obovoid or pyriform, affixed at the base of the peripheric filaments (with which they have a common origin) and concealed among them.

Very unlike the preceding genera in external characters, but closely allied in structure to *Mesogloia*, particularly to *M. vermicularis*. *Leathesia* indeed chiefly differs from *Mesogloia* in having the frond irregularly lumpy or tuberous, instead of cylindrical and branching. The following species has a very wide geographical range, being a common inhabitant of the shores of both hemispheres, East and West, and also of the Southern Ocean. It abounds at least at the Cape of Good Hope.

1. *LEATHESIA tuberiformis*, Gray ; fronds olivaceous, tuberous, when young stuffed with cottony fibres (the axis), at length hollow. *Harv. Phyc. Brit. t.* 324. *Leathesia marina*, Endl.—*J. Ag. Sp. Alg. vol.* 1, p. 52. *Kütz. Sp. Alg. p.* 543. *Corynephora marina*, Ag.—*Rivularia tuberiformis*, *E. Bot. t.* 1956. (TAB. X. C.)

HAB. On rocks and Algæ between tide marks. At Halifax, *W. H. H.*, (v. v.)

Fronds clustered together, varying in size from the bigness of a pea to that of a large walnut, irregularly lobed and bullated ; at first solid but becoming hollow from the perishing of the cottony axial filaments. The frond then consists merely of the peripheric filaments, which are strongly glued together and constitute the whole substance of the walls of the then hollow tuber. They can be separated only by using considerable pressure. The plant makes its first appearance in April or May, and in August or September attains its full size and produces fruit, decaying soon after.

PLATE X. C. *Fig.* 1. Cluster of fronds of *LEATHESIA tuberiformis*, on a piece of rock, the *natural* size ; *fig.* 2, vertical section of a frond, showing a small portion of the periphery, and some of the axial filaments, *magnified* ; *fig.* 3, peripheric filaments supported on the apical cells of the axial filaments ; *fig.* 4, a *spore* and two peripheric filaments, both the latter figures *highly magnified*.

V. RALFSIA. Berk.

Frond coriaceous-crustaceous, fixed by its inferior surface, orbicular, concentrically zoned, composed of densely packed, vertical, simple filaments, agglutinated together into a crust. *Fructification*, depressed warts, scattered over the upper surface, containing obovate *spores*, attached at the bases of vertical filaments or *paranemata*.

The plants included in this group resemble the crustaceous lichens in outward characters, and, like them, spread over the face of rocks in varying patches. In the character of the fructification there is an approach to *Dictyotaceæ*, but the genus is retained in *Chordariaceæ* on account of the structure of the frond, and a supposed affinity with *Leathesia*.

1. *RALFSIA expansa*, J. Ag. ; frond orbicularly expanded into a crust, lobed at the margin, flattish (?) in the middle, here and there raised in tubercles. *J. Ag. Sp. Alg.* 1, p. 63.

On Madrepores in the Gulf of Mexico. Vera Cruz, *Liebman*.

I have not seen this plant, and am uncertain whether I have correctly translated Prof. J. Agardh's specific character, which is as follows :—"Fronde orbiculariter expansa in crustam margine lobatam, medio subcontinuum hic illic in pustulas elevatam."

2. *RALFSIA deusta*, Ag., (not Berk.) ; frond concentrically lobed, the lobes sub-reniform, imbricated, longitudinally striate, concentrically zoned. *J. Ag. Sp. Alg.*, 1, p. 63. *Fucus fungularis*, *Fl. Dan.* t. 420.

HAB. On the shores of Greenland, *Vahl*. Unalaschka, *Tilesius*.

Frond orbicular, 1—2 inches in diameter, adhering to the rocks, constituted of numerous lobes, one imbricating on the other. *Colour* chestnut brown.

I am not acquainted with this plant.

VI. ELACHISTA. *Duby.*

Fronds parasitical, penicillate, composed of axial and peripheric filaments. *Axial* filaments dichotomously branched, cohering together into a tubercular common base. *Peripheric* filaments, simple, free, penicillate, radiating from the base, coloured, articulate. *Fructification*: pear-shaped spores attached to the axial filaments, and hidden within the tubercular common basis.

ELACHISTA *fucicola*, Fries.; tufts pencilled; filaments elongate, flaccid, membranaceous, attenuated upwards; articulations once or twice as long as broad; tubercle spherical. *J. Ag. Sp. Alg.* 1, p. 12. *Harv. Phyc. Brit.*, t. 240. *Phycophila fucorum*, Kütz. *Sp. Alg.* p. 541. (TAB. XI. B.)

HAB. Parasitical on the fronds of *Fucus nodosus* and *F. vesiculosus*. Narragansett Pier, Mr. Olney. Halifax, W. H. H. (v. v.)

A common parasite on littoral fuci, forming brown or foxy-coloured pencils of filaments. I am acquainted only with the two American stations recorded above, but most probably this parasite will be found all along the shores of the Northern States.

PLATE XI. B. *Fig. 1.* Tufts of ELACHISTA *fucicola*, growing on *Fucus nodosus*, the *natural* size; *fig. 2*, a small portion of a tuft *magnified*; *fig. 3*, a spore with paranemata; *fig. 4, 5*, portions of the pencilled filaments, the latter figures *highly magnified*.

VII. MYRIONEMA. *Grev.*

Fronds minute, parasitical, cushion-like, composed of axial and peripheric filaments. *Axial* filaments decumbent, branched, spreading as a thin expansion on the surface to which the parasite adheres. *Peripheric* filaments short, erect, simple, springing from the decumbent expansion, and united by interposed gelatine into a cushion-like frond. *Spores* oblong, affixed either to the erect or to the decumbent filaments.

A genus of minute parasites which annually attack the smaller *red* and *green* Algae in old age, and hasten their decay. The following is so common on old fronds of *Ulva latissima* and *Enteromorpha compressa*, both common American shore plants, that I

venture to introduce it into this work, though I have not received it from any correspondent in America.

MYRIONEMA strangulans, Grev. ; patches convex, confluent, brown ; vertical filaments clavate, densely set ; spores obovoid, on short stalks, attached to the decumbent filaments. *Grev. Crypt. Fl. t. 300. Harv. Phyc. Brit. t. 280. J. Ag. Sp. Alg. 1, p. 48. Kütz. Sp. Alg. p. 540.*

HAB. Parasitical on the fronds of *Ulvæ* and *Enteromorphæ* ; common on the shores of Europe. (v. v.)

This parasite first appears like a dark brown stain, spotting the plant on which it grows, and at this stage consists of little more than an imperfect membranous expansion, composed of prostrate filaments. Afterwards, by the growth of the erect filaments, the spots become convex and gelatinous, and the plant is matured. The spores are of large size (for the plant), and arise, like the vertical filaments, from the upper face of the decumbent ones.

M. Leclancherii, and *M. punctiforme* are, with the preceding, probably to be found on the American shores.

ORDER VI. ECTOCARPACEÆ.

ECTOCARPEÆ, *C. Ag. Sp. Alg. vol. 2, p. 9. (excl. gen.) Harv. Man. Ed. 1, p. 38. Ed. 2, p. 52. Kütz. Sp. Alg. p. 449. ECTOCARPEÆ and SPHACELARIEÆ, J. Ag. Alg. Medit. p. 26. Sp. Alg. vol. 1, p. 6, 27. Dne. Ess. p. 33, 42. Kütz. Phyc. Gen. p. 287, 291. ECTOCARPIDÆ, (in part) and SPHACELARIDÆ, Lindl. Veg. Kingd. p. 22.*

DIAGNOSIS. Olive-coloured, articulated, filiform seaweeds, whose spores are (generally) external, attached to the jointed ramuli, or formed in a swelling of the ramulus.

NATURAL CHARACTER. *Root* commonly a small disc, or point of attachment, occasionally accompanied by woolly fibres. *Frond* filiform and slender, (or *filamentous*) often capillary, or of extreme tenuity, more or less conspicuously articulated, each articulation composed either of several cells of equal length disposed in a ring round an axis, or of a single cell. In the latter case the frond is said to be a *filament* (*filum*, *Ag. trichoma*, Kg.) and is formed of a series of cells, placed end to end, and strung together. In some of the higher forms, as in *Cladostephus* and *Chatopteris*, the main stem and the larger branches are inarticulate, formed of

a multitude of minute cells, the central ones of which are frequently cubical, closely compacted together into a firm, somewhat horny, rigid substance. In a few cases the frond is unbranched (as in the genus *Myriotrichia*) ; very generally it is much divided, either pinnated, alternately branched, or more rarely subdichotomous. In *Cladostephus* the ramuli are short, subsimple, whorled round the branches, and deciduous at the close of each season. In *Sphacelaria* and *Chaetopteris* the ramification is distichous, the lesser divisions being simply or doubly pinnated. In *Ectocarpus* the frond is occasionally subsimple, or but slightly branched ; but in by far the larger number it is much divided, either dichotomous or distichous, and alternately or oppositely branched, but the branches rarely approach so nearly together as to be *pinnated* ; this is however the case in *E. Mertensii*. In some few the thread-like fronds are bundled together into branching ropes, forming a sub-definite, sponge-like, compound frond.

The *fructification* appears under two forms, sometimes both found in the same or on different individuals of the same species ; in other cases but one kind of fruit has been noticed on all the individuals of a species, and hence has been employed as a specific character. The *spores* are less commonly formed than *propagula*, by which name the secondary fruit is known, and are oval or spheroidal, dark coloured, dense, furnished with a hyaline perispore, and attached to the sides of the ramuli, scattered and without paranemata. The *propagula*, which are chiefly characteristic of *Ectocarpus*, where their modifications often afford the best specific characters, are lanceolate, linear or conical, sessile or pedicellate, or immersed in the substance of the branches, transversely striate and filled with dense endochrome. In *Sphacelaria* they are lodged in the distended tops of the branches.

In *substance*, the plants of this Order are rarely gelatinous ; those of the first sub-order are rigid, in some almost horny ; of the latter sub-order soft, and soon decomposing after removal from the water. The colour varies from dark brown to pale greenish-olive, and is subject to little change in drying except on the application of artificial heat, when the olive tints are brightened into more or less vivid greens.

This Order is closely connected with the last, from which it is known by the absence of a gelatinous matrix connecting the filaments into a compound frond, and by the *spores* being external, scattered, and unaccompanied by paranemata. The genus *Elachista* is in some respects intermediate, and has been referred by Prof. J. Agardh to the present Order ; but appears to me to be too intimately connected with *Myrionema* and *Leathesia*, both clearly belonging to Chordariaceæ, to be separated from them.

By Agardh, Endlicher, and formerly by Kützinger, the two sub-orders defined below are separated as distinct Orders ; and by Endlicher they are placed widely apart one from the other. To me their connection appears to be close, and their difference chiefly technical,—one being a rather simpler expression of the other—and therefore I am unwilling to multiply needlessly the number of Orders ; particularly when I find, in such plants as *Ectocarpus Mertensii*, an obvious passage from one sub-order into the other.

These plants are most numerous in the temperate waters of the ocean, diminishing toward the warmer and the colder zones. On the American coast they are more frequent on the shores of the northern and midland States ; and in Europe on the coasts of Britain and France. Several are, however, found in the Mediterranean and Adriatic. They are all plants of small size, though few come within the limits of strictly microscopic objects. The genera are widely dispersed, all nearly cosmopolitan.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

Suborder 1. SPHACELARIEÆ. Frond rigid ; each articulation composed of numerous cells.

I. CLADOSTEPHUS. *Stems inarticulate. Ramuli whorled.*

II. CHÆTOPTERIS. *Stems inarticulate. Ramuli pinnated.*

III. SPHACELARIA. *Whole frond articulate, pinnately branched.*

Sub-order 2. ECTOCARPEÆ. Frond flaccid ; each articulation composed of a single cell.

IV. ECTOCARPUS. *Capillary, soft, much branched.*

I. CLADOSTEPHUS, Ag.

Frond cylindrical, inarticulate, densely clothed with whorled, articulate, short, subsimple ramuli. *Stem* cellular, composed of a triple stratification of cellules ; the central portion of longitudinal prismatical cells horizontally connected ; the intermediate of roundish cells ; the outer of minute cellules. *Fructification*, ellipsoidal spores, having a hyaline perispore, and borne on little stalks on accessory ramuli. The sphacelate tips of the whorled ramuli also contain a sporaceous mass or *propagulum* (?).

Readily known from the rest of the order by the densely-set, quadrifarious, whorled and imbricated ramuli. The two following species are very closely allied to each other, and perhaps not permanently distinct, the differences indicated arising from difference of locality.

1. *CLADOSTEPHUS verticillatus*, Ag. ; branches slender, ramuli mostly forked, regularly whorled ; the whorls at short intervals. *J. Ag. Sp. Alg.* 1, p. 43. *Harv. Phyc. Br. t.* 33. *Cl. Myriophyllum*, Ag. *Kütz. Sp. Alg.* p. 468. *Conferva verticillata*, *E. Bot. t.* 1718, and *t.* 2427, *f.* 2. (TAB. XI. C.)

HAB. On tidal rocks, in pools near low water mark. Perennial. Newport, R. I., *Mr. Olney* and *Prof. Bailey*. Lynn, Mass., *Mr. Hooper*. (v. v.)

Fronds 3—6 or 8 inches high, irregularly dichotomous, innovations springing here and there along the principal divisions. Occasionally a large tuft of such irregular branches issues from a single incrassated portion of the main stem, and is either simple or forked. The whorls of ramuli are about a line asunder, the apices of the lower whorl lying over the bases of that next above ; each ramulus is incurved, tapering to the base, and acute at the extremity, and bears above its middle one or two subulate processes on the outer margin. The articulations are shorter than their diameter, and longitudinally striate, each stria composed of numerous seriated cellules. The fructification is formed in winter, at which season most of the verticillate ramuli fall away, and their place is supplied by short, densely set, accessory ramuli which bear the *spores*. These have been described by authors as a parasitical *Sphacelaria*, and the name *S. Bertiana* bestowed on them.

PLATE XI. C. *Fig. 1*, a frond of *CLADOSTEPHUS verticillatus*, the *natural* size ; *fig. 2*, small portion of a branch, *magnified* ; *fig. 3*, two of the whorled ramuli, *highly magnified*.

2. *CLADOSTEPHUS spongiosus*, Ag. ; branches thick and clumsy ; ramuli mostly simple, irregularly whorled, densely imbricated. *J. Ag. Sp. Alg.* 1, p. 43. *Kütz. Sp. Alg.* p. 469. *Harv. Phyc. Brit. t.* 138. *Conferva spongiosa*, *E. Bot. t.* 2427, *f.* 1.

HAB. On tidal rocks, at about half tide level. Perennial. With the preceding, *Mr. Olney*. (v. v.)

Smaller than the preceding, with thicker and more clumsy branches, and longer and denser ramuli. I am not certain that the American specimens above quoted have been rightly named, or are anything more than a variety of *C. verticillatus*. The British plant looks something different ; but the technical characters by which it is known are not always constant.

II. CHÆTOPTERIS. *Kütz.*

Frond filiform, compressed, inarticulate, distichously pinnate. *Stem* cellular, composed of a triple stratification of cellules; the central portion of longitudinal, prismatic cells, horizontally connected; the intermediate of roundish cells; the outer of minute cellules. *Fructification*:—*spores* (unknown). The sphacelate tips of the pinnated ramuli contain a sporaceous mass or propagulum.

This genus has the habit of *Sphacelaria*, with which it has until recently been associated by authors, and a structure of stem similar to that of *Cladostephus*. It is therefore exactly intermediate between these genera.

1. CHÆTOPTERIS *plumosa*, Kütz.; stems naked at the base, elongated, irregularly branched; branches pectinato-pinnate; pinnae opposite, simple, very long, closely set. *Kütz. Sp. Alg. p.* 468. *J. Ag. Sp. Alg. 1. p.* 41. *Sphacelaria plumosa*, *Ag. Harv. Phyc. Brit. t.* 87. *Conferva pinnata*, *E. Bot. t.* 2330, (*left hand fig.*)

HAB. On the shores of Greenland, *J. Agardh*. Arctic Coast, *Mr. Seeman*. (v. v.)

*Fronde*s from two to four or six inches long, setaceous, naked below, irregularly and much branched above. *Branches* alternate or secund, or frequently tufted, one or two inches long, simple, closely pectinated along their whole length with slender, articulated, distichous ramuli. These ramuli are from one to three lines long, opposite, a pair growing from every joint of the branch.

This beautiful plant is peculiarly a northern form, and though it reaches the south of England, is there of much smaller size than on the shores of Scotland. The branches resemble delicate feathers.

III. SPHACELARIA. *Lyngb.*

Frond filiform, articulated, distichously branched, rigid, pinnated, rarely subdichotomous. *Articulations* of the stem and larger branches composed of several cells radiating from a central point. *Apices* of the branches distended, membranous, containing a sporaceous mass or *propagulum*. *Spores* ovoid, having a pellucid *perispore*, affixed to the branches.

1. *SPHACELARIA cirrhosa*, Ag. ; stems naked at the base, short, densely tufted, simple or branched, pinnate or bipinnate ; pinnæ opposite, alternate or irregular, simple ; spores globose, scattered, sessile or shortly stalked. *J. Ag. Sp. Alg.* 1, p. 34. *Kütz. Sp. Alg.* p. 464. *Harv. Phyc. Brit. t.* 178. *Conf. pinnata*, *E. Bot. t.* 2330. (*right hand fig.*)

HAB. On the small Algæ between tide-marks. Long Island Sound, *Captain Pike*. Ship Ann Point, Con. *Messrs. Walters, Hooper, and Congdon*. New Bedford, Mass. *Mr. Congdon*.

*Fronde*s forming globose, fastigate tufts, an inch or rather more in diameter ; more or less densely tufted, scarcely fastigate, and only a quarter inch in height. *Filaments* capillary, of equal diameter throughout, straight, once or twice pinnated, the pinnæ very irregular ; in some specimens closely set, opposite and plume-like, in others distant, alternate, variable in length on the same branch ; either erecto-patent or spreading horizontally, simple, naked, blunt. The *spores* are not uncommon, and are found scattered along the pinnæ. *Colour* a foxy brown or olive. *Substance* rigid, scarcely adhering to paper in drying.

Probably common on the shores of the Northern and Midland States. Numerous specimens that I have received are very similar to European forms of this variable plant.

2. *SPHACELARIA radicans*, Dillw. ; filaments decumbent, sending out fibrous radicles in the lower part, with a few irregular, simple, straight, naked branches ; spores clustered, sessile. *Harv. Phyc. Brit. t.* 189. *S. olivacea*, *J. Ag. Sp. Alg.* vol. 1, p. 30. *S. radicans* and *S. olivacea*, *Kütz. Sp. Alg.* pp. 463, 466. *Conf. olivacea*, *E. Bot. t.* 2172 ; and *C. radicans*, *t.* 2138.

HAB. On sand-covered rocks, between tide-marks. (I gathered on rocks at Beverley, on Boston Bay, what I supposed to be this species ; but have mislaid my specimens. *W. H. H.*).

A small plant, forming spreading patches half an inch in height, and two inches or more in diameter. The specific name *radicans*, though not adopted by Prof. Agardh in his recent work, has evidently the claim of priority, having appeared in English Botany 34 plates earlier than the rival name *olivacea*—a name moreover, equally applicable to any other species of the genus, all being *olive-coloured*.

IV. ECTOCARPUS. *Lyngb.*

*Fron*d capillary, articulated, variously much-branched, flaccid. *Articulations* composed of a single cell, short, rarely twice or thrice as long as broad. *Apices* attenuated. *Spores* spherical or ellipsoidal, scattered (rarely produced.) *Propagula*, or pod-like bodies, oblong, conical, linear or lanceolate, transversely striate, and celluloso-granulated, formed either of transformed ramuli, or of some portion of a ramulus, or of portions of the main and secondary branches.

A large genus of confervoid Algæ, usually much branched, and forming fine, feathery tufts of slender, soft, brownish or olive green filaments. The articulations are always very short, and nearly of equal size in all parts of the plant. They are usually filled with endochrome, which is sometimes pellucid, sometimes granulated, and sometimes condensed into a dark spot in the middle of the cell. The species are difficult to determine or fix limits to, owing to the uncertain nature of the ramification, which it is by no means easy to characterise, and which appears to vary in different specimens collected together and seemingly of one species. The best characters are derived from the *propagula*, or "silicules," as they have been called; podlike bodies regarded as fructification. These are either formed in the substance of the branches, or of the whole substance of a shortened branchlet. They contain a darker endochrome than the unchanged branches, and are divided at minute intervals by transverse lines. The spaces between the lines are broken up into granular cells disposed in transverse bands, and supposed to be reproductive.

The American species are not yet fully worked out, and though I have proposed some new ones below, I am by no means certain that they ought all to be retained. Some are but partially known, and all require a careful investigation on the sea shore. Solitary specimens of these plants are by no means sufficient, and when any seemingly *new* form is observed among them, numerous specimens ought not only to be collected, but the collector should notice what other seemingly different Ectocarpus was growing with the supposed novelty; and should carefully compare one form with the other before assuming that he has a new species to describe. This cannot be done at a distance, and in many cases I have had to decide from very insufficient materials.

* *Propagula* short or elongated, formed in some portion of the larger or lesser branches, (not in the ultimate ramuli).

1. ECTOCARPUS *brachiatus*, Harv.; finely tufted, feathery, much branched; the branches free, opposite or quaternate; ramuli opposite, very patent; propagula forming oblong or elliptical swellings in the smaller branches, or at the point where two opposite ramuli issue. *Harv. Phyc. Brit. t. 4. J. Ag. Sp. Alg. 1, p. 20.*

HAB. Parasitical on the smaller Algæ. Prince Edward's Island, *Dr. Jeans*. South Boston, *Dr. Durkee*. Lynn, *Mrs. Estes*. (v. v.).

Tufts feathery, 2—4 inches high, the main stems slightly entangled at the base, the lesser branches quite free, spreading. *Filaments* much branched, all the branches and their divisions either opposite or in fours, widely spreading, almost horizontal, the larger divisions subdistant, the lesser gradually nearer. *Ramuli* filiform, patent, mostly opposite. *Propagula* (or perhaps *spores* ?) immersed in the lesser branches, often bipartite. *Colour* a pale olive green.

2. ECTOCARPUS *littoralis*, Lyngb.; tufts dense, interwoven, olive-brown, or olive-green; filaments capillary, much and irregularly branched, the ultimate divisions erecto-patent, alternate or opposite; angles acute; propagula forming elongated, linear swellings in the substance of the greater and lesser branches. *Harv. Phyc. Brit. t.* 197. *J. Ag. Sp. Alg.* 1, p. 18 (?) and *E. firmus*, p. 23.

HAB. Very abundant on littoral *Fuci*; also attached to various substances between tide-marks. Shores of the Northern and Midland States. (v. v.)

Tufts 6—12 inches long, dense and bushy, sometimes bundled together in ropes, sometimes untangled and feathery. *Branches* mostly alternate, repeatedly divided, the divisions issuing at acute angles, the upper ones opposite. *Articulations* of the branches almost as long as broad. *Propagula* elongated, many times longer than their breadth, at first transversely striate, (like an *Oscillatoria*), afterwards moniliform. *Substance* soft, but not glutinous, closely adhering to paper. The colour varies from olive-green to brown; and if dried by artificial heat, the tints may be much vivified and made more green.

This is the commonest form on the American coasts.

* * *Propagula linear or lanceolate, formed of or in the ultimate ramuli.*

3. ECTOCARPUS *siliculosus*, Lyngb.; tufts yellowish or pale olive-green, gelatinous, soft; filaments very slender, excessively branched; ultimate branchlets alternate or secund, attenuated; propagula pedicellate, subulato-lanceolate, attenuated to a fine point. *Harv. Phyc. Brit. t.* 162. *J. Ag. Sp. Alg. vol.* 1, p. 22.

HAB. On various substances between tide-marks. Shores of Long Island Sound, and Hudson River at West Point, *Prof. Bailey*. Prince Edward's Island, *Dr. Jeans*. Charleston, S. C., *W. H. H.* (v. v.)

Tufts 3—6 inches long or more, not entangled. *Filaments* excessively branched, and very slender, all the divisions usually alternate and erecto-patent, with acute

axils. The *propagula* are generally formed of the upper half of the ramuli, leaving an unchanged portion or pedicel at the base of the propagulum: they taper to a fine point, and are sometimes prolonged into ramuli, or tipped with an unchanged mucro. Colour mostly yellowish olive, but variable.

4. ETOCLARPUS *viridis*; tufts feathery, loose, expanding, olive-green; filaments slender, much branched, very flexuous, dichotomous, the lower forkings distant, the upper approximated, having a few lateral ramuli; axils rounded; apices alternate, articulations of the branches once and half as long as broad; propagula sessile or pedicellate, elongate, tipped with a long mucro or unchanged portion of ramulus. (TAB. XII. B. C., two varieties.)

HAB. On Algæ between tide-marks. Charleston, *Prof. L. W. Gibbes*. Providence, R. I., *Mr. Olney*. Bergen Island, *Mr. Walters* and *Mr. Hooper*. Hellgate, *Mr. C. Congdon*. (v. s.)

I fear this is too nearly related to the preceding, notwithstanding the apparently different mode of branching. Dried specimens have the ramuli at the tips of the divisions of the tufts dense, or slightly fastigiate or corymbose, and are of a very green olive. The propagula are more frequently formed in the basal half of the ramulus, and are therefore sessile; but sometimes are found in the middle portion also. The very patent, rounded axils I once thought a good mark, but fear that it is hardly constant enough.

PLATE XII. B. *Fig. 1*, Part of a filament of ETOCLARPUS *viridis*, magnified; *fig. 2*, minute portion, with *propagula*, highly magnified.

PLATE XII. C. *Fig. 1*, Portion of a filament of ETOCLARPUS *viridis*, var., magnified; *fig. 2*, minute portion, with *propagula*, highly magnified.

5. ETOCLARPUS *lutosus*; tufts somewhat entangled and rope-like; filaments intricately branched, decompound, the branches spreading, opposite or alternate, with few, distant, scattered ramuli; angles very wide; articulations of the branches once and half as long as broad; propagula very long, linear, formed in the middle of short, spreading or reflexed ramuli whose base forms a pedicel, and whose apex a long excurrent mucro. (TAB. XII. A.)

HAB. Greenport, Long Island, *Mr. J. Hooper*. (v. s.)

This has the habit of *E. tomentosus*, but branching more like *E. littoralis*. I have seen but a solitary specimen, and though I give it a name, not knowing how to

dispose of it otherwise, I must consider it for the present as a doubtful species ;—*muddy* in more respects than one. Its colour in the dry state is brownish.

PLATE XII. A. *Fig. 1*, Part of a filament of *ECTOCARPUS lutosus*, *magnified* ; *fig. 2*, minute portion, with *propagula*, *highly magnified*.

*** *Propagula* oval, ellipsoidal or conical, sessile or pedicellate, scattered.

6. *ECTOCARPUS tomentosus* ; Lyngb. ; filaments very slender, flexuous, irregularly branched, interwoven into a dense, sponge-like, branching tuft ; *propagula* ellipsoidal, obtuse, pedicellate. *Harv. Phyc. Brit. t. 182. J. Ag. Sp. Alg. 1, p. 23.*

HAB. On various substances between tide-marks. Prince Edward's Island, *Dr. Jeans*. Boston Bay, *Mrs. Asa Gray*. (v. v.)

The sponge-like tufts of this plant, composed of innumerable densely matted, flexuous, branching filaments, are from two to six inches long or more, and divided into several branches, which are either simple or furnished with lesser divisions. The filaments are very slender, and most irregularly branched, the branches flexuous, secund or alternate, and of various lengths. *Articulations* twice or thrice as long as broad, pellucid. *Propagula* pedicellate, linear-oblong or ellipsoidal, very obtuse. *Colour* varying from yellowish olive to dark brown.

The densely interwoven, rope-like, branching tufts at once mark this species from most others.

7. *ECTOCARPUS fasciculatus*, Harv. ; tufts olivaceous, dense ; main filaments not much divided ; the branches distant, set throughout with alternate or secund fascicles of subulate ramuli, the ramuli secund in each fascicle ; *propagula* sessile, secund, several together, ovato-acuminate or subulate. *Harv. Phyc. Brit. t. 273. J. Ag. Sp. Alg. 1, p. 22.*

HAB. On the larger Algæ between tidemarks, generally on the Laminariæ. Rhode Island, *Mr. Olney*, *Prof. Bailey*, and *Mr. G. Hunt*. Also in *Herb. J. Hooper*. (v. v.)

Tufts dense, 3—6 inches long, entangled and rope-like at the base, free and feathery above ; the ultimate ramuli densely aggregated ; appearing under a pocket-lens to be fasciculate, but not strictly so, being only placed in secund series close together. *Articulations* once-and-half to twice as long as broad. *Colour* varying from olive green to dull brown or rusty. *Substance* soft, adhering to paper.

8. *ECTOCARPUS granulosus*, Ag. ; tufts olivaceous, lax, feathery ; filaments capillary, elongate, much branched : branches free, opposite, spreading ; ramuli opposite

or rarely alternate, propagula (spores?) elliptical, dark coloured, sessile. *Harv. Phyc. Brit. t. 200. J. Ag. Sp. Alg. 1, p. 21.*

HAB. On Algæ, etc. between tide-marks, in rock pools. Boston, *Dr. Silas Durkee.* (v. v.)

Filaments capillary, not very densely tufted, from four to eight inches long much branched, with a principal stem and lateral decompound branches. All the divisions mostly opposite and spreading. *Propagula* ellipsoidal, dark-coloured, plentifully scattered on the ramuli.

9. ECTOCARPUS *Durkeei*; tufts not very dense; filaments robust, decompound, much branched, the branches and the lesser divisions alternate; the angles acute and ramuli erecto-patent, attenuated, alternate or secund; articulations of the branches shorter than their breadth; propagula elliptic-oblong, obtuse, subsessile, constricted at the base, transversely striate. (TAB. XII. F.)

Portsmouth, New Hampshire, *Dr. Durkee* (No. 35). (v. s. in Herb. T. C. D.)

Tufts two inches long, hair-like, spreading. *Filaments* much branched, with an evident leading stem, and decompound, alternately divided branches; the main stem and larger branches much more robust than the branches of second or third order, and remarkable for the shortness of their articulations, whose dissepiments are somewhat constricted. The angles are all acute, and the branches and ramuli consequently erect. The propagula are borne toward the base of the smaller branches, and several are generally found together on the same branch. *Colour* olive-green.

The ramification of this plant is most like that of *E. Littoralis*, but the fruit is nearer in form to that of *E. granulatus*. It seems a distinct species, so far as I can judge from the examination of a single specimen.

PLATE XII. F. *Fig. 1*, Portion of a filament of ECTOCARPUS *Durkeei*, magnified; *fig. 2*, minute portions with propagula; *fig. 3*, a propagulum; the latter figures highly magnified.

10. ECTOCARPUS *Mitchellæ*; tufts feathery; filaments very slender, decompoundly much branched, the branches and their lesser divisions alternate; the ultimate ramuli approximated; angles wide, and branches and ramuli patent; ramuli attenuate, articulations of the branches twice or thrice as long as broad, of the ramuli once and half as long, propagula elliptic-oblong or linear, quite sessile and very obtuse, transversely striate, several together. (TAB. XII. G.)

Nantucket, Mass., *Miss A. Mitchell.* (v. s. in Herb. T. C. D.)

Tufts 2—3 inches long, loose, plummy, the ultimate divisions subcorymbose or fastigiata. *Filaments* very slender and much divided, the divisions alternate and patent. *Propagula* abundant on the lesser branches, several together in secund order near the base of the branch, at first ellipsoidal, then linear-oblong, then elongating and linear, always very obtuse and quite sessile, scarcely narrower at the base than above it, sometimes slightly obovoid. *Colour* a yellowish green. To the naked eye this pretty species looks like *E. siliculosus* or *E. viridis*, but the difference in fructification at once separates it from those species. It comes nearer in character to *E. Durkeei*, but is a much more delicate plant, with longer articulations, more patent branching and differently shaped fruit.

PLATE XII. G. *Fig. 1*, Portion of a filament of *ECTOCLARPUS Mitchellæ*, magnified; *fig. 2*, minute portion, with propagula; *fig. 3*, a propagulum; the latter figures highly magnified.

**** *Propagula unknown (probably of the same form as in last section.)*

11. *ECTOCLARPUS Landsburgii*, Harv.; filaments dark brown, tenacious, intricate, much branched; branches irregularly forked, divaricated, zig-zag, bristling with numerous, short, spine-like, horizontal ramuli; articulations short, the endochrome filling the cell, and recovering shape on being moistened, after having been dried. *Harv. Phyc. Brit. t. 233.* (TAB. XII. D.)

HAB. Dredged in deep water. Halifax bay, W. H. H. (v. v.)

Filaments 1—2 inches long, capillary, forming small, intricate tufts, tangled round the branches and roots of various Algæ, and on other submerged substances. *Branches* very widely spreading, often at right angles, variously curved, bent, and divided, almost every articulation emitting a minute spine-like, horizontally patent ramulus. *Colour* dark brown. *Substance* firm, and rather rigid. *Propagula* unknown.

PLATE XII. D. *Fig. 1*, Portion of a filament of *Ectocarpus Landsburgii*, magnified; *fig. 2*, minute portion, highly magnified.

12. *ECTOCLARPUS Hooperi*; tufts rope-like; filaments entangled, flexuous, sparingly and irregularly branched; branches distant, elongate, subsimple, set at subdistant intervals, with short, horizontal, spine-like ramuli; articulations of the branches twice or thrice as long as broad. (TAB. XII. E.)

In *Mr. Hooper's* Herbarium, without habitat (probably Greenport?). (v. s.)

This forms dark brown, rope-like tufts, not unlike some states of *E. tomentosus*, but the filaments are much more robust than in that species. The numerous spine-like ramuli resemble those of *E. Landsburgii*, but are less abundant; and the articulations are much longer than those of that species. It appears to me to be sufficiently characterized, and I hope its discoverer may be able to ascertain the place where his specimen was obtained, and may find it again. At present I have seen but one specimen; Mr. Hooper informs me that he has no duplicate.

PLATE XII. E., *Fig. 1.* Portion of a filament of *Ectocarpus Hooperi*, magnified; *fig. 2,* minute portion, more highly magnified.

13. *ECTOCARPUS Dietzæ*; tufts entangled, floccose; filaments robust, very flaccid, elongate, slightly and distantly branched, subdichotomous (?), flexuous, here and there emitting dichotomous branches; ramuli few, subulate; articulations of the branches once and half as long as broad.

Greenport, *Herb. J. Hooper.* (v. s.)

Forming a pale green, entangled, very flaccid tuft, 4—5 inches long, with the habit of *E. pusillus* or of *E. crinitus*. It seems different from any species of North America with which I am acquainted, but is not sufficiently defined by the above diagnosis. I have seen but one specimen, which adheres so closely to the paper, that it is difficult to remove fragments for examination, and I have found it impossible to display the portion examined, so as to enable me clearly to trace the order of branching. This imperfect examination, and the absence of fructification, compel me to place the species, at present, among the doubtful ones, but I trust more perfect specimens may eventually be obtained. Meantime, the specific name is bestowed in honour of Mrs. DIETZ, of New York; a lady whose diligent researches in marine botany entitle her to this token of respect from fellow-labourers.

ALPHABETIC INDEX OF NAMES.

[The systematic names in capitals are those which are adopted. The names in italic indicate synonyms, whilst the vulgar names are in roman. The asterisks refer to the page of description.]

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SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE.

NEREIS
BOREALI-AMERICANA:

OR,

CONTRIBUTIONS TO THE HISTORY OF THE MARINE ALGÆ
OF NORTH AMERICA.

BY

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PART II.—RHODOSPERMEÆ.

ACCEPTED FOR PUBLICATION

BY THE SMITHSONIAN INSTITUTION,

JULY, 1852.

COMMISSION
TO WHICH THIS PAPER HAS BEEN REFERRED.

PROF. J. W. BAILEY,
DR. ASA GRAY.

JOSEPH HENRY,
Secretary S. I.

SUB-CLASS II.

RHODOSPERMEÆ, OR RED ALGÆ.

DIAGNOSIS. *Plants* rosy-red or purple, rarely brown-red, or greenish-red. *Fructification* of two kinds, diœcious:—1. *Spores* (*gemmidia*, J. Ag.) contained either in external or immersed conceptacles, or densely aggregated together and dispersed in masses throughout the substance of the frond: 2. *Tetraspores* (*sphærospores*, J. Ag. *gemmules*, Thw.) red or purple, either external or immersed in the frond, rarely contained in proper receptacles; each tetraspore enveloped in a pellucid skin (*perispore*) and at maturity separating into four *sporules*. *Antheridia* (not observed in all) filled with yellow or hyaline corpuscles. *Marine*, with one or two exceptions.

The most obvious characteristic of the plants of this sub-class is their colour, though this varies through every shade of red and purple into red brown, or pure brown; and degenerates, under the influences of sun-light and shallow water, into orange, yellow, or dull green. Still, some faint tint of redness, or the absence of *olive-green* or *grass-green*, prevents the student from confounding the faded *Rhodospermeæ* with either of the other groups into which the Algæ are divided.

Their most remarkable and distinctive character however lies in their *double system* of fructification; two descriptions of spore-producing organs having been found in almost all these plants, and always being developed on *different* individuals of each species. Thus, these Algæ are strictly *diœcious*, though in a different manner from other diœcious plants; for here it is not stamens and pistils (or their analogues) which are borne on different roots; but, *some* individuals of a species produce only one kind of pistil or sporiferous organ, and *others* of the same species constantly produce a sporiferous organ of a different kind. These diverse fructifications do not appear to be different phases of the same organ, like the two sorts of flowers found in some *Polygalæ*, *Leguminosæ* and *Malpighiaceæ*, etc.; but are in their origin and development perfectly distinct, and formed with the greatest regularity, following fixed laws. The *spores* developed in either system are equally capable of reproducing the species; and as the two kinds are always formed on different individual fronds, the *idea* of each species of these plants includes two individuals, and is not complete unless both are known. Hence the necessity, in forming our generic groups, to ground them on characters taken from the peculiarities of both fructifications.

Perhaps the natural explanation of this double fructification is to regard one form of reproductive body as the true *spore*, supposed to be fertilized through the agency of an *antheridium*; and to consider the other to be merely a gemmule or bud, here

reduced to a single cell, cast off by the parent plant and capable of continuing an independent existence. If this be the true explanation of the phenomena, we have still to decide (and from analogy only, for evidence of fertilization is wanting) to which of these bodies we shall give the name of *spore*, and which we shall call *gemmule*. And here different botanists take different views, the positive evidence, as it seems to me, being nearly equally in favour of either. Having no new facts to bring forward, I shall not argue this question here; but, adopting the names *spores* and *tetraspores* for these reproductive cells respectively, shall endeavour briefly to describe their development and modification.

1. The *spores*, then, or *gemmidia* of J. Agardh, are always congregated in a more or less definite mass, tuft, or cluster, which we shall here call the *Sporiferous-nucleus* (*Nucleus cystocarpii*, J. Ag.) Each *spore* is a cellule, having a gelatino-membraneous, hyaline coat, and containing a dense, subsolid, homogeneous, deeply coloured starchy mass or *endochrome*, which, on being expressed, breaks up into an impalpable granular dust. The *sporiferous nucleus* is either wholly naked (as in *Wrangelia*, *Callithamnion*); immersed in the substance of the frond (as in *Grateloupia*, *Halymenia*, *Dumontia*, etc.); lodged in wart-like tubercles (as in *Polyides*); or contained within hollow *conceptacles* (or *cystocarpia*, Kütz.) of various forms, which are either dispersed through the frond and partially immersed in it; or are borne on the ends or sides of the branches, on the midrib of leaves, or on proper fructiferous ramuli developed from some part of the stem, or of the margin or disc of the foliations. In all cases of external *conceptacles* they appear to be transformations of the ends of the branches, or of lateral ramuli; the transformed branch or ramulus being usually very much shortened, often reduced to a point. And all immersed *sporiferous nuclei* are formed from the interior strata of cells, and have generally if not always, a connection with the medullary or central stratum.

The *sporiferous nuclei* are of two kinds, distinguished by the manner in which the spores are developed in each. In families of the highest structure (DES. MIOSPERMEÆ) the *nucleus* consists of a tuft of articulated, moniliform filaments, or *spore-threads*, radiating to all sides from a central point, or growing from a proper placenta lodged within a conceptacle. In these nuclei a *single* spore is formed within one or more of the cells of the filaments; and the *spore-thread* at maturity is thus more or less changed into a string of spores. In some, all the cells are changed into spores; in others, the terminal cell is alone fertile. In the less organised families (GONGYLOSPERMEÆ) the *nucleus* is formed either from a single mother-cell, from several detached mother-cells, or from such cells imperfectly joined together in moniliform strings issuing from a central point, or growing from the placenta of a conceptacle. Each mother-cell, which is at first filled with a homogeneous endochrome, becomes, by repeated cell-division, converted into a cluster of *spores*, at first retained within its walls; afterwards, on the bursting of the wall, dispersed. Thus by the evolution of one cell, a *favella*, or simple globose nucleus containing many angular spores within a hyaline periderm, is formed. By the evolution of several detached but adjacent mother-cells, a *favellidium* or compound *favella* results. And by the similar evolution of the cells of the moniliform series, the highest form of *favellidium* is produced. In all these cases the general

nucleus, as well as the particular *nucleoli*, is surrounded by a gelatinous or sub-membranaceous hyaline periderm, derived from the cell walls of the transformed cells.

The classification adopted in this memoir being based on the structure of the *nuclei*, the student will do well, if possible, to master the principles of development now explained. In many cases the structure may be easily seen by viewing under the microscope longitudinal sections of the conceptacle, particularly those of the series *Desmiospermeæ*, where the changes between ripe and unripe fruit are less marked than in the *Gongylospermeæ*. In such plants as *Polysiphonia* and *Laurencia* no careful cutting is necessary, simply bruising the conceptacles between two glasses being sufficient to expel the nucleus. In the *Sphærococcoideæ* and in *Gelidium*, &c. thin cuttings easily made after a little practice under a simple lens, must be viewed by transmitted light. In the *Gongylospermeæ* the proper structure of the *nuclei* is often difficult to be ascertained, owing to the confused crowding of spores which results from the continual self-division of the fertile cells. It may be necessary to examine thin cuttings of various ages in order to determine whether the nucleus be formed from one or many mother-cells. But in most cases where the nucleus is of a large size, very dense, with indications of internal septa, such an origin may be taken for granted. Instances of simple nuclei or *favellæ* favourable for examination occur in *Callithamnion*, *Grateloupia*, *Gloiosiphonia*; and of compound nuclei or *favellidia* in *Chondrus*, *Gigartina*, *Calophyllis*, and *Cystoclonium*.

2. *Tetraspores* (*Sphærosporeæ*, J. Ag. *Tetrachocarpia*, Kütz.) are commonly formed in compound fronds by the evolution of some of the cells of the cortical layer, or in the simple, filiform kinds by the transformation of the ultimate ramuli. They are either dispersed equally through the surface cellules of the whole frond; or confined to the ramuli; or grouped together in definite spots called *sori*; or lodged in external wart-like excrescences (*nemathecia*); or in proper leaflets (*sporophylla*); or in ovate or lanceolate, podlike receptacles (*stichidia*). Wherever placed, they agree in structure; each *tetraspore* containing, within its hyaline, gelatino-membranaceous coat or *perispore*, a dense, four parted, deeply coloured endochrome, dividing at maturity into four (rarely eight or more) *sporules*. The mode of division of the nucleus varies in different species, and should be carefully observed by the student, as generic distinctions are sometimes grounded on this character. In some *tetraspores* the mass is quartered by two lines crossing each other at right angles in the centre; such are called *cruciate* *tetraspores*. In others the mass splits into four unequal parts, three of which only are visible on the lateral view, divided from each other by three lines radiating from the centre; such are called *tripartite*, *ternately parted* or *triradiate* *tetraspores*. Again, there are others, of an oblong or cylindrical form, divided by three parallel, transverse lines into annular portions; and such are called *zonate*, *annular*, or *transversely parted* *tetraspores*.

The natural arrangement of the RHODOSPERMEÆ in Orders and genera offers many more difficulties to the student than that of the MELANOSPERMEÆ, owing to the greater complication of the organs of fructification; the minuteness of the parts which require to be dissected that their proper structure may be understood; the much more varied forms which the *frond* assumes; but especially the great diversity

of *internal* structure which prevails among plants that have *externally* a close resemblance. This last peculiarity compels us, in order to understand their true affinities, to acquire an intimate knowledge of the anatomy of the frond; and this is only to be learned, in the compound species, by a patient examination of transverse and longitudinal slices, always a tedious, and sometimes a difficult process. In the generic distribution proposed by the earlier systematic writers, the external form of the conceptacle, or the colour and substance of the frond, were chiefly considered; in most cases, irrespective of the anatomic structure. Thus, plants the most opposite in internal composition, and producing fructification fundamentally diverse, were often placed in the same genera. A notable instance of such unnatural association occurs in the old genus, *Sphærococcus*, Ag. which included almost every round-fruited species which had no other "local habitation or name;"* and this at the arbitrary will of the author, for the generic character assigned to the assemblage could not be said to apply to a tithe of the species placed in it. Dr. Greville first reformed this group, separating *Rhodymenia*, *Gracilaria*, *Chondrus*, *Phyllophora*, *Gelidium*, *Gigartina*, *Hypnea*, and *Iridæa* from it, a sufficient evidence of the chaos it then contained. No doubt Dr. Greville's system was a vast improvement on that of the elder Agardh; but his genera were often founded on the external habit of the frond, and sometimes included plants as little related *naturally* to each other as those placed in the old group *Sphærococcus*. Thus, *Rhodymenia*, Grev. comprised all the old *Sphærococci* with a red, expanded, membranous, ribless frond, no matter what the internal structure of the frond, or of the fructification. Examination has shown the structure of both frond and fruit to be extremely different among the plants thus associated, and compelled the separation of the new genera, *Calophyllis*, *Rhodophyllis*, *Rhizophyllis*, *Euthora*, and *Calliblepharis*, while of those that remain some belong to *Gigartina*, some to *Gracilaria*; and of the sixteen species enumerated by Dr. Greville, only five belong to the modern genus *Rhodymenia*; the rest dispersing into three different Orders. This example may suffice. Dr. Greville's system was published in 1830. The next decided improvement in system was developed in 1841-1842, by Professor J. Agardh,† who, in describing the Algæ of the Mediterranean and Adriatic, took occasion to reform the generic characters, by introducing into the diagnosis the internal structure of the frond, and by more accurately describing the fructification. Much remained still to be accomplished, and new genera founded on the reformed principles were added by Montagne and others. In 1843 Kützinger published his "*Phycologia Generalis*,"‡ accompanied by eighty anatomical plates of unrivalled excellence and beauty. In this great work many new genera were defined and illustrated, and a new system of distribution was proposed. The chief excellencies of the book are its anatomical illustrations: its faults are, the needless alteration of established names; the introduction of unnecessary glossology; and the multiplication of Orders, genera, and

* CHAR. ESSENT. Fructus uniformis: capsulæ glomerulum seminum minutissimorum sphericum includentes.

† J. Ag. *Symbolæ* in Linnæa XV. p. 1 (1841). J. Ag. "Algæ maris Mediterranei et Adriatici observationes in diagnosi specierum, et dispositionem generum." Paris, 1842.

‡ "Phycologia Generalis, oder Anatomie, Physiologie, und Systemkunde der Tange." Leipsig, 1843.

species, many of them grouping together plants but little related, and others separating nearly allied species. Still, we are indebted to Kützing for reforming many of the old genera left untouched by earlier writers. I regret that in his more recent "*Species*"* he has pursued the deforming, rather than the reforming course, introducing innumerable false species, further subdividing genera, and even placing the same species in two or more widely separated genera.

I turn with pleasure to the work of a very different writer, Prof. J. G. Agardh, whose "*Species,† Genera, et Ordines Algarum*, now in course of publication, places him, for accurate analysis, careful description, original conception, and just views of system, far above any other author who has devoted his attention to the Algæ. In his former works he had sketched out the system which he has now more fully developed, has fortified by the examination of a very large number of species, and remodelled where alterations were necessary. The primary distribution into Orders is based on the structure and development of the *sporiferous nucleus*, which affords excellent discriminative characters. In the generic groups minute attention is paid to the anatomy of the frond, the position and partition of the tetraspores, the minor structure of the conceptacle, &c. The result, I trust, will be to place the systematic arrangement of the Algæ on a better and firmer foundation than it has yet stood. I have carefully gone over, with the dissecting knife and the microscope, much of Prof. Agardh's ground, and though I do not follow him in *all* the changes he has introduced, the points where we differ are few and unimportant, and open to future consideration. With the *principles* advocated in his system I fully coincide; I differ merely in a few cases where it seems to me, perhaps incorrectly, that natural affinity has been mistaken.

I take this opportunity to record the expression of my best thanks to those kind correspondents and friends in America who continue to supply me with specimens. Since the publication of the first part, I have received from Captain NICHOLAS PIKE of Brooklyn an important contribution of Californian Algæ; from DR. BLODGETT of Key West a second interesting series of Floridan Algæ, containing some new forms; from MR. HOOPER a parcel from the North-eastern States, containing several not previously sent; and from MR. CALVERLEY, Algæ of New York Harbour, &c. These and other contributions will be found duly noted under each particular species in the body of the work; and should any novelties reach me before the publication of the third fasciculus, they shall be inserted in a supplement. Persons in America wishing to assist me with further specimens are requested to send parcels addressed to Dr. William H. Harvey, Trinity College, Dublin, to the care of Messrs. Abraham Bell and Son, 25, Park Row, New York; or to J. Van Voorst, Publisher, 1, Paternoster Row, London.

W. H. H.

TRIN. COLL. DUBLIN,
November 24th, 1852.

* *Species Algarum*, auctore F. T. Kützing, Lipsiæ, 1849.

† "*Species, Genera et Ordines Algarum*, auctore J. G. Agardh." Lund, 1848-1852.

SYNOPSIS OF THE ORDERS OF RHODOSPERMEÆ.

Series 1. DESMIOSPERMEÆ, J. Ag. *Sporiferous nucleus* (either naked, immersed in the substance of the frond, or lodged in hollow conceptacles) consisting of tufted spore-threads attached to a basal, parietal, or central placenta. Single spores formed in each cell of the spore thread, or only in the terminal cell.

1. *Nucleus lodged in an external, ovate or spherical conceptacle.*

* *Placenta in the base of the hollow conceptacle. Spores pyriform or obconic, formed in the terminal cell of the spore threads.*

I. RHODOMELACEÆ. *Frond* articulate or furnished with an articulated polysiphonous axis; the surface areolated. *Spore-threads* simple. *Tetraspores* seriated in the ramuli, or in podlike receptacles.

II. LAURENCIACEÆ. *Frond* inarticulate, solid, or tubular and septate; the surface cells minute. *Spore-threads* simple or paniculate. *Tetraspores* irregularly scattered through the ramuli.

** *Placenta in the base of the hollow conceptacle. Spores roundish or elliptical, in moniliform strings; all the cells of the spore-thread gradually changed into spores.*

III. CORALLINACEÆ. *Frond* calcareous (its cells secreting carbonate of lime). *Spore-threads* separating at maturity into four spores.

IV. SPHÆROCOCOIDEÆ. *Frond* cartilaginous or membranaceous. *Spore-threads* separating at maturity into many spores.

*** *Placenta axial, or suspended by filaments in the cavity of the external or half immersed conceptacles.*

V. GELIDIACEÆ. *Frond* inarticulate, cartilaginous or horny, opaque; the axis (at least) formed of elongated, confervoid filaments.

2. *Nucleus not lodged in a hollow conceptacle.*

* *Nuclei contained in wart-like excrescences.*

VI. SPONGIOCARPEÆ. *Frond* cartilaginous (cylindrical) almost wholly composed of confervoid filaments closely set in firm gelatine. *Nuclei* numerous in each wart, globose. *Spores* obconical, radiating from a central point.

- VII. SQUAMARIÆ. *Frond* lichenoid, horizontally expanded and rooting from the under surface, cartilaginous or membranaceous. *Spores* arranged in moniliform strings within the wart.

** *Nuclei immersed in the frond.*

- VIII. HELMINTHOCLADIÆ. *Frond* gelatinous, or gelatino-membranaceous (cylindrical) almost wholly composed of confervoid filaments set in loose gelatine. *Nuclei* spherical, formed of branching, moniliform spore threads issuing from a central point.

*** *Nuclei naked, involucrate.*

- IX. WRANGELIACEÆ. *Frond* filiform, monosiphonous, articulate or corticated with small cells. *Spores* pear-shaped, formed in the terminal cells of branching spore-threads.

Series 2. GONGYLOSPERMEÆ, J. Ag. *Sporiferous-nucleus* (either naked, immersed in the substance of the frond, or lodged in hollow conceptacles) subglobose, either simple or formed of many *nucleoli*. Numerous *spores* congregated without order within a hyaline, mucous or membranaceous periderm (or mother-cell).

* *Frond inarticulate, flat or cylindrical, compound.*

- X. RHODYMENIACEÆ. *Nucleus* lodged in globose conceptacles; *spores* developed within the cells of moniliform, branching filaments issuing from a centre; at length conglobated without order.

- XI. CRYPTONEMIACEÆ. *Nucleus* either lodged within a conceptacle or sunk in the frond; *spores* developed within solitary or aggregated detached mother-cells; at length conglobated without order.

** *Frond filiform, articulate, monosiphonous; the articulations naked, or covered by a cortical layer of small cellules.*

- XII. SPYRIDACEÆ. *Nucleus* lodged in an external, closed cellular pericarp, compound, consisting of many *nucleoli*, each formed by the evolution of paniculately branched spore threads; *spores* at length conglobated without order.

- XIII. CERAMIACEÆ. *Nucleus* (a *favella*) naked or involucrate, simple; containing *spores* conglobated without order within a hyaline membranous periderm (or mother cell), developed externally.

ORDER I.—RHODOMELACEÆ.

Harv. Man. Ed. 2, p. 75. Rhodomeleæ, J. Ag. in Linn. XV. p. 23. Alg. Medit. p. 116. Endl. Gen. 3rd Suppl. p. 44. Harv. Ner. Austr. p. 9; J. Ag. Sp. Gen. and Ord. Algarum, 2, Syn. p. xi. Rytiphleæ, Dne. Class, p. 62, also part of Ceramieæ, Chondrieæ, Thamnophoreæ, and Anomalophylleæ, Dne. l. c. Dasyeæ, Polysiphonieæ, Chondrieæ (in part), Botryocarpeæ (in part), Amansieæ, Rytiphleaceæ, Carpolepharideæ (partly) and Claudieæ, Kütz. Phyc. Gen. p. 414-451.

DIAGNOSIS. Red or brown-red or purple seaweeds, with a leafy or filiform, areolated or articulated frond, composed of polygonal cells; the inarticulate filiform species having an articulated axis composed of cells radiating round a central cell. *Sporiferous nucleus* contained in ovate or urceolate, perforate conceptacles; *spores* pyriform, formed in the terminal cell of unbranched, tufted spore-threads radiating from a basal placenta. *Tetraspores* generally seriated, lodged either in distorted ramuli or in proper receptacles (*stichidia* or *sporophylla*).

NATURAL CHARACTER. *Root* either a simple disc, or accompanied by creeping fibres; sometimes, in densely tufted filiform kinds, the primary fronds are prostrate, attached by lateral discs issuing along them at intervals, the secondary ones or branches erect. *Frond* very variable in habit, either leaflike or filiform; or rarely formed into an anastomosing net-work. In the numerous forms found in various parts of the world all gradations between a perfectly developed, nerved, expanded leaf, and a capillary, articulated filament, finer than human hair, may be traced. In the flat, leaf-like species, the frond is sometimes (as in *Odonthalia*) thick, opaque, with minute surface cells, and either destitute of midrib or obsoletely ribbed; sometimes (as in *Amansia*) it is delicately membranaceous, translucent, composed of regular twelve sided cells of equal length, arranged in transverse lines. Similar varieties occur in the cylindrical fronds, some of which are opaque, with small surface cells (*Alsidium*, *Acanthophora*, *Rhodomela*); others (as many *Polysiphonieæ*) are pellucidly articulate. This latter character, in several *Polysiphonieæ*, distinguishes all parts of the frond at all ages; in others only obtains in the young frond, or in the younger branches and ramuli of older fronds. In such the articulations are gradually coated over by successive rows of smaller cells of unequal size and shape, and can only be discovered by making cross and longitudinal sections of the stems. A cross section being made, an articulated axis composed of several cells disposed like the spokes of a wheel round a central cell may be

detected in all the plants of this order, and affords a mark by which they may generally be recognised when not in fruit. The growing ends of the branches and ramuli are clothed with articulated, mostly dichotomous, monosiphonous hairs or *ramelli*, and sometimes the whole surface of the frond is thickly covered with them. In most cases they are deciduous, falling away soon after the point from which they spring becomes fully developed, but sometimes (as in *Dasya*) they are persistent, either remaining unchanged, or, (in the section *Stichocarpus*) eventually becoming polysiphonous and changing into ramuli.

Considerable uniformity prevails throughout the Order in the structure of the organs of fructification. The conceptacle in all is of the form technically called *ceramidium*, that is, an ovate or urceolate hollow case, pierced by a terminal pore, and containing a tuft of spore-threads radiating from a basal, more or less elevated placenta. These conceptacles are formed at the ends or sides of the branches or ramuli, and are always transformations of shortened ramuli, or of the apices of branches. The *spores* are pear-shaped, tapering greatly to the base, and are formed singly from the terminal cells of the spore-threads. The *tetraspores* in all cases, so far as I am aware, are tripartite or unequally triradiate—three of the sporules only being visible at either face. They are never equally dispersed through the frond, and only in a few cases lodged in its unaltered ramuli. Most usually they are produced in little ovate or lanceolate, pod-like *receptacles* called *stichidia*, developed either from the midrib, the disc, or the margin of the leafy species; or formed within the axils of the ramuli; on the ends of the branches; or even on the permanent hairs (as in *Dasya*) that clothe the surface. The distinctive generic characters often depend on the occurrence, the form, or the position of the *stichidia*. *Antheridia* have been found in several *Polysiphoniæ*, *Rhodomelæ*, *Dasyæ*, &c. They occur in the form of minute pod-like bodies, resembling the *stichidia* in shape, but much smaller, filled with exceedingly minute granular cells, and are usually of a pale yellow colour. They are mostly developments of the dichotomous hairs that crown the growing ends of the branches.

The order *Rhodomelaceæ*, though including within its limits many brilliant Algæ, contains a large proportion of darker and more soberly coloured species. It takes its name from one of the genera (*Rhodomela*) which is noted for changing from red to black during the process of drying, and very many others have similar properties. In *Odonthalia* the growing frond is blood red, while the dried is dark vinous purple. Many rosy or purplish leafy kinds change to dull brown. Brown again, of various depths and shades, is the proper colour of several *Polysiphoniæ*; while others of that genus, though equally brown when dry, are a pure crimson or purple when growing. In so large a genus all hues of red, as may be supposed, are found, and are more or less lost or preserved in drying. The genus *Bostrychia* is remarkable for the depth and dulness of its purple colour, the only varieties being tinges of green, or of black or very dark brown. *Dasya* among the American genera shines out in greatest lustre, its soft fronds (as in *D. elegans*), clothed with a rich fleece of rosy purple; a colour which is preserved or even heightened in the drying specimen.

None of the North America genera of this order are peculiar to the coasts of

this continent, and most are widely scattered. *Amansia*, *Alsidium*, *Acanthophora* and *Digenia* are either tropical or subtropical. *Odonthalia* is confined to the colder regions of the Atlantic and Pacific, and to the circum-polar Ocean. Perhaps its most southern limit in Europe is the Isle of Man (lat. 54° 20'), while in America it extends from the Arctic Coast at least to Halifax Harbour (lat. 44° 35'). *Rhodomela* is distributed in high northern and southern latitudes. There is a species (*R. concinna*, Hook. and Harv.) at the southern extremity of the New Zealand group, closely related to *R. floccosa* of our north-west coast; and others occur at the Falkland Islands and Cape Horn. *Rytiplæa* is for the most part subtropical, but some of its species on the West Coast of Ireland reach to lat. 55°. *Polysiphonia* and *Dasya* may be said to be cosmopolitan. Of the former, between two and three hundred species have been described, probably a third too many. Several of these are found in the Eastern and Western Hemispheres, as well as in parallel climates north and south of the line. *P. fastigiata* is a very constant parasite on *Fucus nodosus*, wherever that grows. *P. nigrescens*, under one or other of its forms, prevails along the Atlantic shores; and *P. urceolata* and *formosa* are equally spread abroad. *Dasya elegans*, so abundant from Long Island Sound to Florida, has an equally wide range in Southern Europe; and a closely allied species, *D. villosa*, abounds in Van Dieman's Land. It is remarkable that *D. coccinea* so common on the shores of Europe has not yet been found in America, and that the North American species most nearly related to it has been brought from Puget's Sound, on the Pacific coast.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

* *Fronde flat, pinnatifid.*

I. AMANSIA. Translucent, distinctly midribbed, membranaceous; the membrane formed of large, hexagonal cells, disposed in transverse rows.

II. ODONTHALIA. Opaque, obsoletely midribbed, thickish, composed of minute cells; those of the surface very minute, irregularly polygonal.

** *Fronde filiform, inarticulate; the surface cells minute, of irregular form, and irregularly placed (not in transverse lines). Ramuli similar to the rest of the frond in structure.*

III. ALSIDIUM. Laxly cellular; the *ramuli* short, spinelike, transversely striate. *Stichidia* axillary, tufted, fusiform.

IV. ACANTHOPHORA. Laxly cellular; the *ramuli* spinelike, opaque. *Stichidia* (formed in swollen *ramuli*) subglobose, thorny, sessile.

V. CHONDRIA. Laxly cellular; the *ramuli* clubshaped, much attenuated at their insertion. *Tetraspores* lodged in the *ramuli*.

VI. RHODOMELA. Densely, cellular; the *branches* and filiform *ramuli* opaque, not transversely striate. *Tetraspores* in the terminal, filiform *ramuli*.

VII. RYTIPHLÆA. Densely cellular with an articulated axis; the *ramuli* (at least) transversely striate or subarticulate. *Tetraspores* in the terminal, fusiform *ramuli*.

*** *Frond* filiform, inarticulate, opaque. *Ramuli* articulate, longitudinally multistriate.

VIII. DIGENIA. *Ramuli* subsimple, quadrifarious, densely imbricated.

**** *Frond* filiform, either partially or wholly articulate, or tessellated (i. e. the surface cells coequal, arranged in transverse rows.)

IX. POLYSIPHONIA. *Frond*, at least the younger parts, obviously articulate; the articulations longitudinally two or many-striate.

X. BOSTRYCHIA. *Frond* tessellated with quadrate or oblong, purple cells.

***** *Frond* filiform or compressed, inarticulate or subarticulate, beset with byssoid, single-tubed, articulate *ramelli*, which bear the fructification. *Stichidia* fusiform.

XI. DASYA.

I. AMANSIA. Lamour.

Frond flat, delicately membranaceous, transversely striate, rosy purple, pinnatifid, midribbed; the membrane formed of oblong, hexagonal cells, of equal length, arranged in zones across the frond; the midrib slender, disappearing towards the apices. *Conceptacles* subglobose, sessile, marginal, containing a tuft of pear-shaped spores. *Stichidia* marginal, branched, containing a single or double row of tetraspores. *Antheridia* ovate, stipitate, borne on and about the inrolled apices of the lacinulæ.

A small genus of tropical or sub-tropical Algæ, resembling *Delesseria* in habit, but readily known, even without fruit, by the structure of the frond, which under a pocket lens appears to be finely striate transversely, and with a glass of greater magnifying power is seen to be composed of hexagonal cells of equal size. The membrane is thin, composed of two strata of cells, with thin walls, containing rosy endochrome.

1. *AMANSIA multifida*, Lamour. ; stem vaguely branched, obsoletely winged, bearing numerous, irregularly placed, ovate, deeply bi-tri-pinnatifid fronds, prolific from the midrib ; laciniae linear, with a very slender nerve ; lacinulae broadly subulate, their apices strongly inrolled. *Lamour. Bull. Phil.* 1809. t. 6. *Ag. Sp. Alg.* 1. p. 192. *J. Ag. in Linnæa.* XV. p. 26. *Odonthalia multifida*, Endl. 3d. *Suppl.* p. 47. *Epineuron multifidum*, Kütz. *Sp. Alg.* p. 848.

HAB. Abundantly cast up at Key West, *W. H. H. &c.* (v. v.)

Tufts much branched. *Stems* three to four inches long, cartilaginous, naked or winged with the remains of a membranous lamina, throwing out numerous, irregularly placed, leaf-like, secondary fronds, which are sometimes distant, sometimes densely crowded, when the plant becomes an intricate, globose mass of fronds. These secondary fronds are ovate or ovato-lanceolate in outline, either pinnatifid, bipinnatifid or tripinnatifid, delicately membranaceous, their main rachis traversed by a strong cartilaginous midrib, which gradually becomes thinner and fainter upwards ; their pinnae and pinnules marked by a very fine, depressed central line. The midribs of the larger branches are frequently proliferous. The apices of all the pinnulae are strongly rolled inwards. I have not seen fruit of either kind ; but what appear to be *antheridia* are very common (in February) crowding around the tips of all the laciniae, the usual position in Algæ of this order : they are pedicellate, ovate, filled with minute grains. *Colour* a purplish pink, becoming browner in drying, and soon fading in fresh water. The substance is rather rigidly membranaceous, and in drying the plant does not adhere to paper.

Endlicher has strangely misunderstood the affinities of this plant, by placing it in *Odonthalia*, a genus with a very different structure.

II. ODONTHALIA. *Lyngb.*

Frond flat or nearly so, thickish, subopaque, distichously pinnatifid, obsoletely midribbed, the margin alternately toothed. *Structure* densely cellular ; the surface cells very minute, polygonal, irregular in size and form. *Conceptacles* marginal, mostly axillary, pedicellate, ovate, wide-mouthed, containing a tuft of pear-shaped spores. *Stichidia* marginal, mostly axillary, stipitate, corymbose, lanceolate, containing a double row of tetraspores.

This group, separated from *Rhodomela* by Lyngbye, has been generally received by botanists, and by all but Endlicher, with nearly the same limitation. It differs from *Rhodomela* in the nearly flattened, two-edged, broadly linear frond, the middle portion of which is thickened into a more or less evident costa ; and in the position of the fructification in axillary processes. The species have all been found in the

Northern Ocean, our American one being common to the north of Europe, and the other known species to the north-eastern shores of Asia.

1. *Odonthalia dentata*, Lyngb.; decompoundly pinnate; branches oblong, deeply pinnatifid or bipinnatifid; laciniae alternate, linear, sharply inciso-dentate toward their truncated extremities; conceptacles and stichidia both clustered, axillary. *Harv. Phyc. Brit. t. 34 (colour incorrect)*. *Kütz. Sp. Alg. p. 846*. *Fucus dentatus*, *Linn. Turn. Hist. t. 13. E. Bot. t. 1241*.

HAB. On rocks and stones in deep water. "Shores of America," *Gmelin*. Dredged in Halifax Harbour, *W. H. H.* Arctic Coast, *Mr. Seeman*. (v. v.)

Fronds 3-12 (in the Halifax specimens 4-5) inches long, decompoundly pinnatifid, the main divisions irregular, the secondary and subsequent regularly alternated, and erecto-patent. The main branches are evidently ribbed towards the base, where the marginal wing is narrow and frequently defective, and become less obviously ribbed, broader, flatter and thinner upwards. The secondary branches have an oblong or lanceolate or sometimes a flabelliform outline and are alternately pinnatifid; the lowest laciniae short, broadly subulate, tooth-like, the upper gradually larger and alternately inciso-dentate or again pinnatifid. In the specimens with flabelliform branches the upper laciniae are proportionably much longer and more compound, all their divisions spreading. *Axils* very obtuse. *Apices* acute. The internal structure is dense, the substance composed of innumerable small, polygonal cells, closely packed together; those of the surface exceedingly minute. *Fruit* (which I have not seen on American specimens) borne on little marginal processes either in or near the axils of the laciniae; both conceptacles and stichidia tufted. *Colour*, when growing, a clear, full, blood-red, becoming darker and changing either to vinous purple or to brown red; when dried the tips sometimes assume a pinky tint.

The American specimens are smaller and narrower than the generality of those of British growth, but I can find no distinctive character, and have seen some from Orkney equally narrow. The *O. angustifolia*, Suhr, judging from a specimen in Herb. T. C. D., is a different species, seemingly the same as *O. Kamtchatica*, Rupr. The colour of the plate given in *Phycologia Britannica*, copied from a dried specimen, is very incorrect; when growing, this plant is of a clear, translucent red.

III. ALSIDIUM, *Ag.*

Frond filiform or compressed, cartilaginous, pinnately or irregularly decompound, opaque, coated with small polygonal, irregularly placed cells; *axis*

articulated, polysiphonous. *Ramuli* alternate, subulate, acute, transversely striate. *Conceptacles* inflated, solitary, with contracted and produced apertures, containing within a membranous pericarp a tuft of pear-shaped spores on simple funiculi, radiating from a basal placenta. *Tetraspores* tripartite, lodged in axillary, tufted, lanceolate receptacles (*stichidia*), irregularly seriated.

As revised by J. Agardh (Linnæa, vol. XV. p. 28.), this genus is nearly related to *Acanthophora* on the one hand, and to *Rhodomela* on the other. The species are all from the warmer parts of the ocean. I have seen only the *conceptacles* of *A. Seaforthii* and *A. Blodgettii*; and only the *stichidia* of *A. triangulare*.

1. *ALSIDIUM triangulare*, J. Ag.; frond triquetrous, between dichotomous and pinnate, much branched; branches alternate or secund, closely set throughout with minute, trifarious, bifid, trifid or multifid ramuli; *stichidia* axillary, tufted. *J. Ag. in Linnæa XV. p. 28.* *Bryothamnion triangulare*, Kütz. *Sp. Alg. p. 842.* *Physcophora triangularis*, Kütz. *Phyc. Gen. p. 434. t. 57. fig. 1.* *Thamnophora triangularis*, Ag. *Syst. Alg. p. 240.* (TAB. XIII. A.)

HAB. Abundantly thrown up at Key West. (A common West Indian species). (v. v.)

Frond 6-12 inches long or more, excessively branched. *Stem* cartilaginous, cylindrical below, where it is frequently two lines in diameter, gradually becoming narrower and more compressed upwards, forking repeatedly and then irregularly divided. *Branches* scattered, triangular, with a flabelliform outline, much divided; the lesser branches alternate or secund, having shorter branchlets toward the apices. All the younger parts of the frond are set, at distances of a line or two, with minute, trifarious, mostly three pronged ramuli, not a line in length: these, as well as the younger part of the branches, appear transversely striate when examined with a pocket lens. *Conceptacles* I have not seen. *Stichidia* densely tufted in the axils of the trifid ramuli, distorted, more or less fusiform, tapering to a point, each containing three or four large tetraspores in an imperfect line. A cross section of the frond shows a small axial cell surrounded by eight *primary* cells (or *siphons*), outside which are several rows of irregularly polygonal cells, which diminish in size to the circumference. The surface cellules are very minute, so that the branches appear opaque and inarticulate. *Colour* when fresh a clear purplish pink, soon fading in the sun, and becoming reddish brown in the herbarium. *Substance* cartilaginous, very tough, and not in the least adhering to paper in drying.

PLATE XIII. A.—*Fig. 1.* A small plant of *ALSIDIUM triangulare*; the natural size. *Fig. 2,* apex of a branch with three-pronged ramuli; *fig. 3,* tuft of *stichidia* containing *tetraspores*, removed from the axil of a ramulus; *fig. 4,* a transverse section of the frond;—the latter figures more or less highly magnified.

2. *ALSIDIUM Blodgettii*, Harv.; frond sub-compressed below, terete above, decompound pinnate; pinnae alternate, patent, close, virgate, the lowest very long, set with short, setaceous, spinous-toothed, alternate, distichous ramuli; upper branches short and sub-simple; conceptacles pedicellate, inflated, urceolate, variously placed on the ramuli. (TAB. XV. B.)

HAB. At Key West, *Dr. Blodgett*, (No. 73.) St. Marks, Florida, *Mr. Hooper*. Apalachicola, *Capt. Pike* (v. s. in Herb. T. C. D.).

Frond of unknown length, probably a foot or more. *Branches* pinnate or bipinnate; the lowermost pinnae long, simple or again pinnate; the upper much shorter or altogether abortive, so that the apices of the branches project, like long tails, beyond the bushy part of the frond. All the divisions are very patent, the primary and secondary ones almost horizontal. The secondary (or pinnae) are distichous, about two lines apart, and are from two to three inches in length, about the thickness of hog's bristle, gradually tapering to a point. Near the base they are generally bare of ramuli, or are merely toothed, but for the greater portion of their length are set with distichous bristle-shaped ramuli, a line apart and two or three lines long. These ramuli are regularly spinoso-dentate. The *conceptacles*, which are abundant on some of my specimens, are as large as poppy-seed, inflated, thin walled, with a prominent, contracted orifice, and contain a very large tuft of pear-shaped spores. They are placed either just above the axils of the ramuli, or at their apex, or along their margin, and appear to be formed by a metamorphosis of the spinous teeth which regularly alternate, in distichous order, along all the branches and ramuli. A cross section of the stem shews a central cavity surrounded by five primary cells, outside which several large cells are interposed between the primaries and the peripheric cells. The *colour* appears to have been a clear, full red, fading to yellowish on exposure. The substance is cartilaginous, but somewhat tender, and the plant, in drying, adheres pretty strongly to paper.

For a knowledge of this very interesting plant, I am indebted to my friend Dr. Blodgett of Key West, whose name I have therefore bestowed upon it. At the time the figure and description were made, I had seen but a single specimen; but have since received numerous and beautiful specimens from Dr. Blodgett, in all important respects agreeing with that first found. Captain Pike and Mr. Hooper have communicated, from the mainland of Florida, less perfectly preserved specimens; which, notwithstanding some minor differences, I refer without hesitation to this species. I think it can hardly be doubted to belong to the same natural genus as *A. Seaforthii*, though abundantly distinct from that species.

Plate XV. B. *Fig. 1.* A branch of *ALSIDIUM Blodgettii*, the *natural* size. *Fig. 2.* apex of a branch, with toothed ramuli and conceptacles; *fig. 3.* a conceptacle and ramulus removed; *fig. 4.* spores from the conceptacle; *fig. 5.* transverse section of the stem; the latter figures more or less highly *magnified*.

IV. ACANTHOPHORA. *Lamour.*

Frond filiform, cartilaginous, irregularly decompound, opaque, coated with small, polygonal, irregularly placed cellules; *axis* articulated, polysiphonous. *Ramuli* densely crowded on all sides of the branches, short, spinelike, acute. *Conceptacles* urnshaped, perforate, borne on the ramuli, containing within a cellular pericarp a tuft of pear-shaped spores on simple funiculi radiating from a basal placenta. *Tetraspores* tripartite, lodged in globose receptacles (*stichidia*) formed in swollen ramuli.

A small genus composed of a few tropical or subtropical species, the distinctive characters of which are not well defined. They become very dark, often nearly black, in drying, and are readily known by their spinelike ramuli. The natural habit is nearly the same as in *Alsidium*, but the stichidia have a different origin, being here formed out of the very substance of the ordinary ramuli, and not a special axillary growth.

1. ACANTHOPHORA *Thierii*, Lamour.; irregularly pinnate or bi-pinnate, or not much branched; branches long, subsimple, tapering, beset throughout with quaquaversal, subulate ramuli, which are densely clothed with simple or trifid spines. *Lam. Ess. p. 44. Kütz. Sp. Alg. p. 858. Fucus acanthophorus, Lamour. Diss. t. 30 & 31. f. 1. Turn. Hist. t. 32. A. militaris, Lam. A. muscoides, Grev. (TAB. XIV. A.)*

HAB. "Shores of North America," *Lamoureux*. Key West, *W.H.H.* (No. 4). Key West and Conch Key, *Prof. M. Tuomey* (41, 42, 43). (v. v.)

Fronds 3-6 inches long, half a line in diameter, alternately or irregularly branched; branches sometimes closely placed, sometimes distant, erecto-patent, long, little divided, flexuous, sometimes having a few secondary branches above, beset throughout at distances of a line apart with quaquaversal, very patent, short ramuli. *Ramuli* one or two lines long, densely bristled with short, simple or trifid, broadly subulate, patent or reflexed spines. *Conceptacles* urn-shaped, with a contracted orifice, seated on the sides or tip of the ramulus, and formed out of one of its spines. A cross section of the frond shows five large primary cells surrounding a small central cavity, and a wide border of smaller irregularly angular cells, gradually diminishing in size towards the periphery, which is formed of very minute cells. No outward appearance of articulation, or transverse striæ. *Colour*, a dark, lurid purple, becoming brown or even black in drying. *Substance* cartilaginous, firm. By pressure the plant may be made to adhere partially to paper in drying.

I regret that I had not noticed the conceptacles, which I find on one of Prof. Tuomey's specimens, in time to introduce a figure of them into the plate.

My specimens agree very fairly with the figure and description of *Lamoureux*

quoted above, except that Lamouroux represents the spiniferous ramuli shorter than I find them. He received the plant on which he founds his species from "North America," but was uninformed of the exact locality where it was gathered. I have little hesitation, therefore, in adopting his specific name. Nor do I hesitate to refer the *A. muscoides*, Grev., typified by Turner's plate 32, nor the *A. militaris*, Lamour., to the same species; for though my specimens from Key West are much less copiously branched than the figures given by the authors just named, yet I find such a series of connecting links in numerous specimens from St. Croix, which I owe to Miss Dix, and specimens from Chili collected by Baron de Selding, that I cannot point out any valid difference. Some are scarcely branched, others closely pinnate or bi-pinnate, and both forms sometimes occur in the same tuft. I am not alone in this opinion, doubts of the validity of *A. muscoides* being held by Dr. Montagne, (*Nat. Hist. Cuba*, p. 43,) who has kindly sent me a specimen of his plant, and it closely agrees with some of my Key West specimens.

PLATE XIV. A. *Fig. 1*, Frond of *ACANTHOPHORA Thierii*; the *natural* size. *Fig. 2*, a spiniferous ramulus; *fig. 3*, cross section of the stem; the latter figures more or less *magnified*.

2. *ACANTHOPHORA Delilei*, Lamour.; much branched and bushy, decompoundly pinnate or irregularly divided; branches beset with long and short, sub-spiniferous ramuli, and with solitary, distant, short spines. *Lamour. Ess. p. 44*; *Kütz. Sp. Alg.*, 858; *Phyc. Gen. t. 52, f. 4*; *Fucus naiadiformis*, *Delile, Egypt. t. 56, f. 1*.

HAB. At Sand Key and Key West, *W. H. H.* (No. 3.) (v. v.)

Fronds in large tufts, 4—6 inches long, one-third of a line in diameter, excessively branched from the base. *Branches* alternate or secund, rarely opposite, spreading, simple below, beset with secondary branches above. These secondary branches are often again pinnate or bipinnate with lesser ramuli of unequal lengths. *Ramuli* either naked, or having a few distant, horizontal spines, or regularly beset with alternate spines. The larger branches also are furnished with scattered, simple, solitary spines. *Substance* cartilaginous. *Colour* dull purple, or brownish, becoming very dark when dry, in which state the plant imperfectly adheres to paper.

This is a more slender and much more diffusely branched plant than the preceding, from which it is technically distinguished chiefly by the scattered solitary spines, found on all the branches in greater or less plenty. Our specimens agree in most respects with specimens from the Mediterranean, but I am not without doubts, whether the differences indicated between this plant and *A. Thierii* are valid.

V. CHONDRIA. *J. Ag. ref.*

Fronds filiform, cartilaginous, pinnately decompose, opaque, coated with small polygonal, irregularly placed cells. *Axis* articulated, polysiphonous. *Ramuli* club-shaped, very much constricted at their insertion, obtuse or sub-acute, transversely striolate. *Conceptacles* ovate, perforate, sessile or pedicellate on the ramuli, containing, within a cellular pericarp, a tuft of pear-shaped spores on simple funiculi radiating from a basal placenta. *Tetraspores* tripartite, crowded irregularly in the club-shaped ramuli, formed from the endochrome of the radiant cells.

Frond of a cartilaginous or subgelatinous substance, soon decomposing in fresh water, and generally closely adhering to paper in drying, filiform, more or less regularly pinnately decompose, but not strictly distichous. *Branches*, and their subsequent decompositions, simple, virgate, attenuated at the base and apex, set with more or less abundant lateral, scattered, spirally inserted simple ramuli, which are always very much constricted at the base, and either abruptly truncate or attenuate at the apex. The surface of the frond is composed of small irregular oblong cells, through which the internal articulated axis is rarely visible, except in the ultimate ramuli of some species. This *axis* is formed of four or five large oblong cells of equal length, disposed in a radiant manner round a central cell. Some species are rosy purple, staining fresh water carmine; others in steeping give out a brown fluid of offensive odour, and stain paper a fulvous brown; others are dark purple, or tinged with green. *Conceptacles* generally on the sides of the ramuli, mostly ovate and subsessile. *Tetraspores* lodged within the axial cells of the ramuli, one or more in each cell, large, irregularly crowded near the extremities.

A large genus, the species of which until recently have been arranged among the *Laurenciæ*, from which position Prof. J. Agardh has very properly separated them. Their agreement with *Laurencia* (typified by *L. pinnatifida* and its allies) is more in external habit than in structural character. They differ especially in the articulated polysiphonous axis, a character by which they are associated with the *Rhodomelaceæ*. Besides the North American species described below, I possess some imperfect specimens from Key West, which I have not been able to refer to their proper place; and probably other new species may remain to reward a diligent search on the shores of the Southern States.

1. CHONDRIA *sedifolia*; frond alternately much branched; branches patent, decompose, beset with short, spindle-shaped, scattered or tufted ramuli much contracted at the base, and sub-acute or obtuse at the apex; conceptacles ovate, sessile on the ramuli. (TAB. XVIII. G.)

HAB. Key West, Mr. Binney, W. H. H., Dr. Blodgett, (33, 34, &c.) Prof. Tuomey, (45, 52, &c.) (v. v.)

Frond 4-6 inches long, as thick as sparrow's quill, much branched, either with a leading stem pinnated or bipinnated with lateral, closely set, patent branches; or alternately or irregularly multifid, the branches straight or curved, spreading in all directions. *Branches* once or twice compound, sometimes nearly naked, but oftener densely clothed with ramuli about a line in length, and very much constricted at the base, acute or obtuse at the apex. *Conceptacles* ovate, wide-mouthed, sessile on the ramuli. *Tetraspores* in the ramuli of distinct plants. *Colour* a dark reddish-brown, fading to yellow. *Substance* cartilaginous, less apt to decompose, than others of the genus. In drying it adheres to paper.

Perhaps only a variety of *Ch. dasyphylla*, but the habit is very peculiar.

Plate XVIII. G. *Fig. 1.* Branch of *CHONDRIA sedifolia*, the natural size. *Fig. 2,* small portion, with ramuli and conceptacles, magnified.

2. *CHONDRIA dasyphylla*, Ag.; frond robust, elongate, alternately much branched; branches simple or decomposed, beset with short, clubshaped or topshaped, blunt ramuli, much constricted at the base. *Ag. syst. Alg. p. 205. Laurencia dasyphylla, Grev.—Harv. Phyc. Brit. t. 152. Kütz. Sp. Alg. p. 853. Fucus dasyphyllus, Turn. Hist. t. 22. E. Bot. t. 847.*

HAB. On Algæ, &c. between tide marks. Annual. Newport, *Mr. Olney*. Peconic Bay, *Prof. Bailey, and W. H. H.* Key West, *W. H. H., Dr. Blodgett, (23, 24) (v. v.)*

Fronds tufted, 6-12 inches long, as thick as a crow quill, cylindrical, not much attenuated upwards. *Stem* rarely parted towards the base into several branches, generally undivided, set with lateral branches which are either simple or furnished with a second or third series. *Ramuli* a quarter to half an inch long, blunt, much constricted at the base. *Colour* a purple brown, becoming duller in drying. The substance of the growing plant is firm and cartilaginous, but soon becomes flaccid in the air, and if left a short time in fresh water the ramuli fall off and the frond rapidly decomposes, tinging the water dark brown. It closely adheres to paper in drying.

The North American specimens are a little different from the common European form, most of the ramuli, though blunt, being rounded, not truncate at the top. In one of my Greenport specimens, however, I find the ramuli as abruptly truncate as in the normal condition of the species.

3. *CHONDRIA Baileyana*, Mont.; frond setaceous, much branched below; branches long and virgate, erect, subsimple, beset throughout with scattered, simple or pinnated, slender, curved ramuli which are greatly attenuated to the base and obtuse at the apex; conceptacles pedicellate, on the ramuli. *Laurencia Baileyana, Mont. in An. sc. nat. 3rd Ser. Vol. 2, p. 63. (TAB. XVIII. A.) var. β. with a leading stem closely pinnated with lateral branches.*

HAB. On Algæ, &c. near low water mark. Annual. A common plant in Long Island Sound. Newport, *Prof. Bailey*. New Bedford, *Dr. Roche*. Little Compton, &c. *Mr. Olney*. Seacannot, *Mr. Congdon*. New York Harbour, *Prof. Bailey*, *Mr. Hooper*, and *Mr. Calverley*, &c. (v. v.)

Fronde densely tufted, 6-8 inches long, as thick as hog's bristle, generally with a short stem soon dividing into several long, rodlike branches. *Branches* erect, 4-5 inches long, simple or once or twice compound, set at short intervals with slender ramuli, which at first are simple, and afterwards pinnulated or even bipinnulated with similar smaller ramuli. The ramuli spread to every side and are very generally curved, from a quarter to half an inch long, much attenuated to the base, somewhat narrowed upwards, but ending in a blunted, roundish point. The *conceptacles* are ovate, on little stalks rising from the sides of the ramuli; and the *tetraspores* are generally confined to the apices. *Colour*, when growing in deep water, a fine brownish purple. In fresh water it soon gives out a rose-coloured fluid which stains the paper on which the specimen is displayed, and to which it closely adheres in drying. *Substance* soft and tender.

This plant varies very much in ramification. The specimens described by Dr. Montagne appear to have been but little branched, the branches springing near the base. I have seen such, but they do not convey an adequate idea of the ordinary form, which is usually much more decompound. Some specimens have a leading, stem closely pinnated with branches; and in others the branches are bipinnate with very densely set, plumose ramuli. As a species it is almost exactly intermediate between *Ch. dasyphylla* and *Ch. tenuissima*, having the slender habit of the latter, and ramuli almost as blunt as in the former, though much more attenuated.

Plate XVIII. A. *Fig. 1.* CHONDRIA *Baileyana*, the natural size. *Fig. 2.* portion of a branch, with ramuli and *tetrasporic* fruit; *fig. 3.* apex with tetraspores; *fig. 4.* a tetraspore; *fig. 5.* ramulus with conceptacles; *fig. 6.* a conceptacle; all more or less highly magnified.

4. CHONDRIA *tenuissima*, Ag.; frond slender, terete, irregularly divided; branches long and virgate, clothed with very slender, setaceous ramuli, which taper much to the base and the acute apex. *Ag. Syst. Alg. p. 205.* *Laurencia tenuissima*, Grev.—*Harv. Phyc. Brit. t. 198.* *Alsidium tenuissimum*, Kütz. *Sp. Alg. p. 843.* *Fucus tenuissimus*, Turn. *Hist. t. 100.* *E. Bot. t. 1882.* (TAB. XVIII. F.)

HAB. Boston Bay, and New Haven, *Dr. Durkee*. Hell Gate, New York, *Mr. Hooper*, (v. v.)

Fronde 4-6 inches long, about twice as thick as hog's bristle, with an undivided stem set with lateral, mostly alternate spreading branches. *Branches* simple or pinnated with a second series of similar branches, and furnished throughout with

more or less abundant setaceous ramuli from a quarter to half an inch in length and mostly simple. *Ramuli* very narrow, fusiform, tapering much to the base and to the acute apex. *Conceptacles* ovate, on the ramuli, mostly pedicellate. I have not seen tetraspores on American specimens. *Substance* cartilaginous, tender. In drying the plant adheres to paper.

Apparently rare on the American coast. The few specimens which I have seen have the essential characters of the European form, but are less luxuriant.

Plate XVIII. F. Fig. 1, branch of *CHONDRIA tenuissima*; the natural size. Fig. 2, small portion with ramuli, *magnified*.

5. *CHONDRIA littoralis*; frond robust, elongate, subdichotomous or irregularly much branched; branches flexuous, attenuated, with rounded axils; ramuli scattered or crowded, fusiform, attenuated to the base and apex, simple or pinnulated, acute. Var. β . ramuli very densely crowded, pinnate and bi-pinnate; conceptacles ovate, sessile, near the tips of the ramuli.

HAB. On the Florida Keys. Abundant at Key West, near high-water mark. *W. H. H., Prof. Tuomey*, (58, 59, &c.) (v. v.)

Tufts very large and dense, often spreading over a considerable space. *Fronde* twelve inches long or more, as thick as crow's quill or somewhat thicker below, attenuated upwards, much and very irregularly branched; the main stem once, twice or many times forked, the arms spreading widely. Sometimes two, sometimes three branches spring from each fork. *Branches* of unequal length, erect, flexuous, tapering to the apex, either nearly naked or more or less abundantly furnished with slender ramuli. The older parts are generally denuded, but in var. β . all the branches are densely beset with pinnato-multifid ramuli. *Ramuli* a quarter to half an inch long, lineari-fusiform, much attenuated at the base, curved, tapering to an acute or subacute point. *Conceptacles* ovate, sessile. *Colour* a pale yellowish fawn, with a reddish tinge. *Substance* cartilaginous, soon decomposing in fresh water. In drying it stains the paper brownish yellow.

In mere technical character this approaches *Ch. tenuissima*, but is a much larger, coarser and less regularly branched species. It abounds along the shore at Key West, after growing quite up to high water limit. It is one of the least ornamental of the genus.

6. *CHONDRIA atropurpurea*; frond robust, dark coloured, inordinately much branched; branches patent, the secondary ones, as well as the scattered ramuli tapering to the base and attenuated to an acute point; conceptacles unknown. (TAB. XVIII. E.)

HAB. Sullivan's Island, Charleston, *Prof. L. R. Gibbes*, *W. H. H. Apalachicola*, *Mr. Hooper*, (97.) (v. v.)

Fronds tufted, in our specimens about four inches high, but the full grown plant is probably much taller, as thick as sparrow's quill or somewhat thicker, irregularly branched, the branches alternate or unilateral, spreading at wide angles or nearly at right angles to the point from which they spring, curving upwards and bearing several irregularly placed, erect, secondary branches. These latter are narrow-fusiform, one or two inches long, much constricted at the base, and tapering to an acute point. They are sometimes naked, but more commonly set with small ramuli of similar shape and one to three lines in length. The colour is a dark, blackish purple. The substance is firmly cartilaginous, and in drying the plant adheres to paper.

Our specimens, gathered early in January, are evidently immature, and therefore this species must remain somewhat doubtfully characterised. I think it however essentially different from any of those described in this memoir. Its nearest affinity seems to be with *Ch. capensis* (Harv. *Ner. Austr. t.* 31.) but in the absence of more certain evidence, it would be premature to unite them. I find among Dr. Coulter's Californian plants a *Chondria* which agrees in most respects with our Charleston specimens, and may belong to the same species. But I am unwilling to confuse the subject by quoting it under this species, or unnecessarily to add to the number of species by describing it as different. I hope Prof. L. R. Gibbes, by visiting the above locality a month or two later in the season, may succeed in finding more complete specimens than we have yet procured. Among Dr. Blodgett's Key West specimens are two, (No. 27 and 29) possibly referable to our *Ch. atropurpurea*, but, for the reason just given, I forbear quoting them under it. One has large, ovate, stalked conceptacles; the other tetraspores in the ramuli.

Plate XVIII. E. Fig. 1. Branch of *CHONDRIA atropurpurea*, the *natural* size. Fig. 2, small portion with ramuli, slightly *magnified*. Fig. 3. longitudinal section of the stem, more highly *magnified*.

V. RHODOMELA. Ag.

Frond filiform or subcompressed, cartilaginous, decompose-pinnate, opaque, densely cellular within, coated with minute, polygonal, irregularly placed cells; *axis* articulate, polysiphonous. *Ramuli* filiform. *Conceptacles* ovate, pedicellate or sessile, containing within a membranous pericarp a tuft of pear-shaped spores on simple funiculi radiating from a basal placenta. *Tetraspores* immersed in the swollen, ultimate divisions of the branches, rarely in proper stichidia.

The species included in this group are natives of the cooler portion of the temperate zone, both of the northern and southern hemispheres. They are naturally

associated together by a common habit, but it is not easy to point out a clear generic character which will separate them from *Rytiphleæ* and from the more opaque species of *Polysiphonia*, from which genera they chiefly differ in their denser cellular substance and the absence of all appearance of articulation in any part, even the youngest, of the frond. In a young state, or when the frond is in active extension, the apices of the branches are clothed with dichotomous fibrils, resembling in structure, and no doubt analogous to, the ramelli of *Dasya*; but these fibrils are fugacious, as in *Polysiphonia*, &c.

Of the North American species, three belong to the Pacific, and three to the Atlantic Coast.

1. RHODOMELA *Larix*, Ag.; frond robust, terete, alternately branched; branches long, subsimple, densely clothed with quaquaversal, tufted, inflexed, subulate ramuli; stichidia attenuate, among the clustered ramuli. *Ag. sp. Alg.* 1, p. 376. *Lophura Larix*, Kütz. *Sp. Alg.* p. 850. *Fucus Larix*, Turn. *Hist. tab.* 207.

HAB. Pacific Coast from the shores of the Arctic Sea (*Seeman*) to Monterey, abundantly. *Coulter! Tolmie! Wilkes! Garry! &c.* Discovered at Nootka Sound by *A. Menzies, Esq.* (v. s. in Herb. T. C. D.)

Frond 6-14 inches long or more, terete, the thickness of a crowquill, undivided to the height of two or three inches, thence upwards much branched. *Branches* alternate, 4-6 inches long, simple, or bearing in the upper half several secondary branches, and, occasionally, in luxuriant specimens, a third set. The lower part of the stem is commonly bare, or clothed with the broken stumps of old branches, but all the younger parts of the frond are densely covered on all sides with spirally disposed tufts of short, inflexed, subulate ramuli, two or three lines in length. These ramuli spring from very short or abortive lateral branchlets on which they are inserted one above the other, but so near together as to appear fascicled. Sometimes the axis of the fascicle is a little lengthened and then the ramuli appear scattered, but are still very closely placed. Judging from dried specimens the ramuli are laterally compressed, shaped like the blade of a knife. The false *stichidia* are formed from the inner or upper ramuli of the fascicles, and are generally found on such specimens as have the axis of the fascicles a little lengthened. They are more slender than ordinary ramuli, and of greater length, but scarcely less opaque: the *tetraspores* are small. *Conceptacles* ovate, crowding at the base of the tufted ramuli, being formed from the inner ones of the fascicles. *Substance* coarse, between coriaceous and cartilaginous. In drying the plant becomes almost black, and does not adhere to paper.

2. RHODOMELA *floccosa*, Ag.; stem filiform below, compressed above, alternately branched; branches spreading, subsimple, pinnated throughout with short, alternate, distichous, fasciculato-multifid, compressed ramuli; stichidia lanceolate, formed

from the ramuli ; conceptacles ovate, terminal. *Ag. Sp. Alg.* 1, p. 376. *Lophura floccosa*, Kütz. *Sp. Alg.* p. 850. *Fucus floccosus*, *Turn. t.* 8, *Esper t.* 100.

HAB. Pacific coast at Port Trinidad, lat. 41° 12', *Mr. Menzies*. Sitcha, *Ruprecht* ! Nootka Sound, *Barclay* ! Monterey, *Dr. Coulter*. Off the west coast, lat. 32°, *Lieut. Wood*, H.M.S. "Pandora." (v. s. in herb. T. C. D.)

Frond 5–10 inches long, filiform below, soon compressed and becoming more compressed toward the extremity, twice as thick as hogs' bristle, with a leading stem which is once or twice pinnated in its upper half with lateral, alternate, erecto-patent branches. *Branches* distichous, subsimple, sometimes with a second series from their upper half, regularly beset throughout with alternate, distichous, multifid branchlets, one or two lines in length. These branchlets are alternately decompound, their lowest ramulus simple and subulate, those over it again and again compounded ; each ultimate division of the frond slender, subulate, acute, incurved. *Conceptacles* ovate, usually terminating the compound multifid branchlets, being formed from their last developed ramuli. *Stichidia* lanceolate, apiculate, formed of the inner or upper ramuli of the branchlet, and containing a double row of tetraspores. *Colour* in the dry state dark brown or black ; probably red brown when recent. *Substance* rigid. It does not adhere to paper in drying.

A smaller and slenderer plant than the preceding, with distichous ramification and a more developed axis to the multifid branchlets. It is closely related to *R. subfusca*, but the habit is peculiar, and the compression of the frond an obvious character.

3. RHODOMELA *pilulifera*, Grev. ; frond robust, cartilaginous, terete or compressed, decompound ; branches distichous, alternate, distant, not much divided ; ramuli few, scattered, subulate, the lowest short and spinelike, the upper somewhat filiform ; conceptacles very large, globose, terminal or sessile near the ends of the branches. *Grev. Hist. Alg. Brit. p.* li. *Sphærococcus pilulifer. Ag. syst. p.* 236. *Fucus pilulifer* or *globulifer*, *Turn. Hist. t.* 236.

HAB. Nootka Sound, 1778, *A. Menzies, Esq.* (v. s. in Herb. Menzies.)

Frond 6 inches long or more, twice or thrice as thick as hog's bristle, irregularly decompound, but not much branched ; branches distant, alternately divided twice or thrice, the penultimate divisions somewhat virgate, either naked or with a few distant, short, spinelike, alternate, distichous ramuli below, and several larger and more filiform subulate ramuli in their upper half. Branches and ramuli compressed when dry, but becoming nearly terete when moistened. *Substance* very opaque and rigid. Structure as in *R. subfusca*. *Conceptacles* larger than poppy-seed, spherical, terminating the branches or sessile near the ends of the ramuli. *Colour* very dark.

Turner rightly refers this species to the neighbourhood of *R. subfusca*. Indeed, conceptacles apart, it is not easy to distinguish it from the battered, winter condi-

tion of that variable plant. Turner describes the frond much more compressed than I find it in the specimen preserved in Mr. Menzies' Herbarium. A cross section after expansion shows the branches to be nearly cylindrical.

4. *RHODOMELA subfusca*, Ag.; frond filiform, much branched; the branches irregularly divided, clothed with pinnated branchlets, and subulate, simple, scattered or subfasciculate ramuli; pinnules subulate, terete; conceptacles subsessile; tetraspores in the somewhat swollen, (but neither moniliform nor attenuated) terminal ramuli (in summer), or in proper branching stichidia issuing irregularly from old stems (in winter.) *Ag. Sp. Alg. vol. 1. p. 378. Harv. Phyc. Brit. t. 264. Lophura cymosa, Kütz. Sp. Alg. p. 850.*

HAB. On rocks and stones near low water mark. Halifax, *W. H. H.*; Boston, *Dr. Durkee!* Lynn, *Mrs. Estes!* Boar's Head, New Hampshire, *Capt. N. Pike!* Newport, Rhode Island, *Prof. J. W. Bailey!* Staten Island, New York. (v. v.)

Fronds tufted, 6-12 inches long, quarter to half a line in diameter at base, filiform, attenuated upwards, much branched and bushy. *Branches* alternate, distichous or subspirally inserted, the secondary ones decompound, about bipinnate; tertiary branches furnished in the lower half with simple, alternate, sub-distant, subulate ramuli; above furnished with more compound, pinnulate or multifid ramuli, which are densely crowded about the ends of the branches. *Conceptacles* ovate, nearly sessile (not seen on American specimens). *Tetraspores* contained in the terminal, subulate or slightly fusiform, terminal ramuli, solitary or in pairs, not wider than the places where they occur. *Colour*, a dark, brownish red, becoming much darker in drying. *Substance* cartilaginous, somewhat rigid. In drying, the plant adheres, under pressure, to paper, but not with much force.

In winter the smaller branches fall away, leaving a few naked stems, and at that season tetraspores are frequently found in little, lateral, accessory stichidia, emitted without order by the broken branches. In spring, these denuded plants put forth a profusion of pinnato-multifid branches, being much more bushy than plants of the first season.

My Halifax specimens are very robust. The rest are of the ordinary form so common in Europe.

5. *RHODOMELA gracilis*, Kütz.; frond flaccid, ultra-setaceous below, soon divided and then excessively branched and bushy, decompound pinnate; the branches setaceous below, capillary above, repeatedly divided alternately; penultimate ramuli distant, dichotomo-multifid above the middle, attenuate; conceptacles pedicellate, somewhat racemose; tetraspores in the attenuated, moniliform, terminal ramuli. *Lophura gracilis, Kütz. Sp. Alg. p. 850. Rhodomela subfusca (in part) Ag. l. c. supra. Lyngh. Hyd. Dan. t. 10. fig. B. C. Tab. XIII. C.*

HAB. Prince Edward's Island, *Dr. Jeans*. Halifax, *W. H. H.* Boston Harbour, *Mr. G. B. Emerson*. Plymouth, Massachussetts, *Prof. J. W. Bailey*. (v. v.)

*Fron*d from four to ten or twelve inches long, divided a little above the base into a multitude of slender stems, about twice the diameter of hog's bristle below, but soon attenuated and reduced to a hair-like fineness. *Stems* many times decompound in an alternate or secund order, spuriously dichotomous by the occasional suppression of a branch; the axils distant, rounded. Secondary *branches* long, and about bipinnate; the pinnæ distant, simple below, alternately or subdichotomously multifid beyond the middle. Ultimate *ramuli* capillary, very much attenuated, and tipped with a pencil of slender, dichotomous fibrils. Sometimes the ramuli are densely crowded at the ends of the branches, sometimes not so. *Conceptacles* broadly ovate, on short stalks, racemose along the terminal ramuli, very abundant on fertile plants. *Tetraspores* in pairs, immersed in the slender ultimate ramuli which then become beaded by the bulging out of the tetraspores, which are much broader than the places where they occur. *Colour* a brownish red, becoming dark brown in drying. *Substance* very soft and lubricous. In drying, this plant adheres closely to paper.

Allied to *R. subfusca*, with which Agardh unites it, but differing in being of very much softer substance, more bushy and decompound, and especially in the large size of the tetraspores, causing the beaded appearance of the fertile ramuli. I have very numerous specimens from Dr. Jeans, presenting several varieties. Some to the naked eye have the aspect of *Polysiphonia Brodiaei*, for which they may readily be mistaken without microscopic examination; others resemble *Pol. violacea* outwardly. All adhere with great closeness to paper, and must have been very lubricous when fresh.

PLATE XIII. C. *Fig. 1.* Upper portion of a dichotomo-multifid branchlet of *RHODOMELA gracilis* with tetrasporic fruit; *fig. 2,* moniliform apex of one of the ultimate ramuli of the same; *fig. 3,* a tetraspore; *fig. 4,* a conceptacle; *fig. 5,* transverse section of a branch; all the figures more or less *magnified*.

6. *RHODOMELA Rochei*; frond setaceous, flaccid, rosy red, terete, decompound, pinnate, distichous; lesser branches bipinnate; pinnæ naked below, pinnulate beyond the middle; pinnules fastigate, bifid or multifid at the tips, and copiously fibrilliferous; conceptacles racemose, on longish stalks. (TAB. XIII. B.)

HAB. New Bedford, Massachussetts, *Dr. M. B. Roche and Mr. C. Congdon*. Yellow Hook, New York, *Mr. Walters and Mr. Hooper*. (v. s. in Herb. T.C.D.)

*Fron*d four to eight inches long, setaceous at base, attenuated upwards and at length capillary, divided from the base into many decompoundly pinnate branches or secondary stems. Lesser branches alternate or secund, distichous, patent, one to three inches long, bipinnate or tripinnate, oblong in outline, obtuse and fastigate. *Pinnæ* naked for the lower half, pinnated above, the pinnulæ spreading and bifid,

trifid or multifid at the tips, so that the tips appear to the naked eye as if capitate, and dark coloured. At a later period, this character is lost by the lengthening out of the cloven tips into new ramuli. *Conceptacles* on longish stalks, abundant on the ultimate ramuli, converting them into racemes. *Tetraspores* unknown to me. Abundant dichotomous fibrils clothe the ends and sides of the ultimate ramuli. *Colour* a fine red, communicating a rosy tinge to the paper on which the plant has been dried, and to which it closely adheres. *Substance* flaccid.

I am disposed to keep this beautiful plant separate from *R. gracilis*, to which, in its soft substance and slender stems, it is most nearly allied. It differs in being still more slender, of a brighter colour, with more distichous habit. The pinnated branching is much more definite than in either *R. gracilis* or *R. subfusca*. The name is given in compliment to Dr. M. B. Roche of New Bedford, from whom I first received it, and to whom I am also indebted for many other beautiful specimens of Algæ.

VI. RYTIPHLÆA. *Ag.*

Fronde filiform or compressed, decompound pinnate, transversely striate, areolated; the axis articulated, composed of a circle of large, tubular, elongated cells of equal length, surrounding a central cell; the periphery of one or more rows of small irregularly shaped cells. *Conceptacles* ovate, pedicellate or sessile, containing a tuft of pear-shaped spores on simple funiculi radiating from a basal placenta. *Tetraspores* contained in the terminal fusiform ramuli or in proper stichidia, in a single or double row.

The structure of the frond in this genus is very similar to that of the opaque and inarticulate portions of several *Polysiphoniæ*, in which the articulated axis, composed of symmetrical cells radiating round a central cavity, is coated externally with numerous rows of cells irregularly shaped and placed; of these the inner ones are large and often empty, the outer gradually smaller and more constantly containing bags of coloured matter. The difference between the genera is almost wholly technical, *Polysiphonia* having at least its younger portions destitute of the peripheric layer of cells, and *Rytiphlæa* having these parts coated, though less perfectly than the other portions. The transversely striate appearance of the *Rytiphlææ*, which is best seen with a common pocket lens, arises from the nodes of the enclosed articulated axis being visible through the coat of peripheric cells. Of course, this appearance is most obvious in the younger parts, where the cellular coat is less dense. The species of *Rytiphlæa* are few, and mostly tropical or sub-tropical.

1. *RYTIPHLÆA*? *Baileyi*; frond compressed, areolated, irregularly branched; branches closely bipinnate; pinnae alternate, nearly equal, patent; pinnulae subulate, subarticulate, the lowermost simple, the upper ones sometimes cloven, all slightly inflexed.

HAB. Monterey Bay, California, *Prof. Bailey*. (v. s. in Herb. T.C.D.)

Frond compressed, inarticulate, two or three inches long, half a line in diameter, divided near the base into several branches, which are closely bi-tripinnate throughout. *Pinnae* not two lines asunder, very patent, half an inch to an inch long, compressed, closely pinnulated with subulate slender ramuli, the lowermost of which are simple and subdistant, the upper frequently again compounded, being pinnulated with a third series of ramuli. *Ramuli* acute, transversely striate and subarticulate, with hexagonal cells of nearly equal length and breadth. *Antheridia* oblong, crowding round the tips of the ramuli. Stem and branches perfectly inarticulate, areolated with polygonal cells of irregular shape and size. *Colour*, when dry, a dark purplish brown. *Substance* rigid. It does not adhere to paper.

Allied to *R. complanata*, but the surface cells are of larger size, and the ramuli more evidently articulated. Indeed, except for the habit, which is that of a *Rytiphlaea*, this plant might be placed in *Polysiphonia*.

VII. DIGENIA. *Ag.*

Frond filiform, rigidly horny, irregularly branched, inarticulate, densely cellular, the surface cells minute; branches densely clothed on all sides with rigid, hairlike, subsimple, articulated, longitudinally striate ramuli. *Conceptacles* (unknown). *Tetraspores* lodged in the swollen ramuli.

The single species for which this genus has been set apart, though common in the Mediterranean, the Red Sea, the Indian Ocean, and in the warmer parts of the Atlantic, is still imperfectly known, its conceptacular fruit having hitherto escaped notice. In assigning it a place among the *Rhodomeleæ*, the structure has alone guided us; the internal anatomy of the stem and branches being nearly similar to that of the same parts in *Rhodomela*; while the ramuli are formed something on the type of those of a *Polysiphonia*, or perhaps more nearly still on those of a *Bostrychia*. The longitudinal striæ of the internodes do not consist of a single elongated cell, as in *Polysiphonia*, but of a string of cells.

DIGENIA simplex, Ag. *Sp. Alg.* 1. p. 388. *Digenia Wulfeni*, Kütz. *Phyc. Gen.* t. 50. f. 2. *Sp. Alg.* p. 841. *Conferva simplex*. Wulf. *Fucus Lycopodium*, Turn. *Hist. t.* 199. (TAB. XIII. D.)

HAB. Abundant at Key West, W. H. H. &c. Key Biscayne, Prof. Tuomey, (No. 61. 62).

Fronde 4-8 inches long, as thick as crow's quill, irregularly dichotomous or alternately branched; the branches either simple or bearing near the summit a second series of lesser branches; sometimes very bushy. The lower parts of the stem are generally bare, but the upper half and all the branches are very densely clothed on all sides with shaggy, setaceous ramuli, from a quarter to half an inch in length. These ramuli are filiform, simple or slightly branched, articulate, the internodes about as long as broad, coated with small cells arranged in many longitudinal lines. A cross section of a ramulus shows a central tube with two or more series of radiating cells set round it. I have not found fruit on my specimens. *Colour* when quite fresh a dark brownish red, becoming brown in drying and dirty white after exposure to the sun. *Substance* very rigid and horny, tough. In drying, the plant does not in the least adhere to paper.

A very coarse, shaggy plant, apt to be infested with numerous vegetable and animal parasites, particularly corallines. It is very difficult to find specimens free from extraneous growth, or having the ramuli perfect. In our figure the parasites are omitted.

Plate XIII D. *Fig. 1.* *DIGENIA simplex*, the natural size. *Fig. 2.* Some ramelli, springing from a fragment of the stem; *fig. 3.* portion of a ramellus; the two latter figures more or less highly magnified.

VIII. POLYSIPHONIA. Grev.

Fronde filiform, rarely sub-compressed, articulate (at least the younger parts, the older having an articulate axis); internodes of the stem (or axis) composed of numerous, tubular, elongated cells of equal length, radiating round a central cell, and generally containing endochrome. *Conceptacles* ovate or urceolate, containing a tuft of pearshaped spores. *Tetraspores* imbedded in the distorted, ultimate ramuli.

An immense genus inhabiting all regions from the Polar basin to the equator; very variable in size and external habit—some species being two to three feet in

length, others not more than as many tenths of an inch ; some dichotomous, others pinnated—some distichous and fern-like, others with a bushy or arborescent character ; some of cobweb delicacy, lubricous and excessively flaccid, soon decomposing, others robust, rigid or tough, of strong enduring substance ;—some of a brilliant rosy red or crimson, others (and the greater number) varying through all the graver shades of red-brown, brown, and purple ; some inhabiting the deep sea, others occurring only near high water mark or far up the estuaries of tidal rivers. Plants of such varied aspect and habit could not have been brought together by the universal consent of botanists, among whom there has never been much difference of opinion respecting the just limits of this genus, if they had not some obvious bond of union in an essential, easily seen, and important common character. This is found in the structure of the stem in the articulated species, and of the axis of the stem in species which appear to be partially inarticulate ; the dissepiments being hid by the growth of a thin or thick layer of epidermal cells round the stem or branches. In such species, the proper structure of the genus may generally be seen, without dissection, in all the younger parts, as in the upper branches and ramuli. The species simplest in structure have the internodes or *articulations* of the stem and branches composed of four large cells containing endochrome or colouring matter, placed crosswise round a small, central, empty cavity, as shown in section at Pl. XVI. B. fig. 7. When viewed laterally, internodes of this structure may exhibit either two cells, or one cell and two half cells, appearing to the eye as three, the middle one twice the breadth of the others. Such stems are said to be four-tubed, or bi-tri-striate. In some species which are of this character small cells (*secondary* cells) are formed external to the four *primaries*, and alternating with them, as shown in Pl. XVII. A. fig. 6, and B. fig. 7 ; and in others, as at Pl. XVI. A. fig. 4, a thick epidermal layer of small cells surrounds the *primary* tubes, and such stems become apparently inarticulate, the *articulation* being concealed beneath the coat of small surface cells, as at fig. 5. By turning to the figures, the gradual complication of a stem of four primary tubes will be readily understood ; and the same occurs where there are more primaries than four, as at Pl. XVI. D. fig. 5, Pl. XVII. C. fig. 3, which latter figure shows the commencement of secondary tubes in a polysiphonous stem. The stem and branches of all the species are formed on one or other of these models, the number of primary tubes being sometimes as many as twenty-four.

In studying the species, it is absolutely necessary to make cross sections of the stem in order to be able to count the number of primary tubes in each internode ; for though the exact number is not of specific importance in the polysiphonous species, where we find the same species varying in different specimens from 12 to 20 tubes, yet it is essential to determine whether there be only four, or more than four ; and, generally speaking, the species with fewest tubes are most constant to their number. A little practice will enable the student to make the necessary sections with the help of a small-bladed knife and a botanical simple microscope, for which may be substituted a watchmaker's eyeglass. A small piece of a stem or branch, say a quarter of an inch long, is firmly held by the finger of the left hand upon a slip of glass under the lens, while thin slices, the thinner the better, are cut

from it. These wheel-like slices, floated in a drop of water, may then be placed under the compound microscope and examined. In slicing dried specimens, it is best to cut the stem, if possible, before it be moistened; as a thinner and cleaner cut can then be made, and the risk avoided of the too rapid decomposition from the fresh water. When the cells refuse to resume their proper shape on remoistening, a drop of muriatic acid will frequently, but not always, expand them.

Nearly 300 species of *Polysiphonia* are to be found described in various books,—Kützinger has collated 248 in his latest work. Of these, perhaps one-third are false species, founded either on solitary or on insufficient specimens. The whole require a careful revision and examination of the original materials. As in all large genera, it will be found that some species are very constant to certain characters, while others are so variable that it is nearly impossible to limit them within a short specific phrase. Of this last character are many *Polysiphoniæ*, and the knot of difficulty has too often been cut by splitting such species into several, a practice which, once admitted, leads to continual dismemberment. I shall endeavour to avoid unnecessary division in defining the American species.

SUBGENUS 1. OLIGOSIPHONIA. Primary tubes, four only. (Sp. 1—17.)

* *Stem visibly articulate throughout, with pellucid dissepiments.* (Sp. 1—13.)

1. *POLYSIPHONIA urceolata*, Grev.; filaments rigid, setaceous, full-red, much branched, loosely bundled; branches subdichotomous, furnished with short, alternate, patent or recurved decompound ramuli; internodes four-tubed, those of the branches 3-5 times longer than broad, of the ramuli very short; conceptacles stalked, urn-shaped, with a projecting narrow orifice; tetraspores in the ultimate ramuli. *Grev. Fl. Edin. p. 309. Harv. Phyc. Brit. t. 167. Kütz. Sp. Alg. p. 824. β. patens*; with the lateral ramuli more numerous, strongly recurved, or revolute. *P. patens*, Grev. *Kütz. l. c. Conferva patens*, Dillw. t. G.

HAB. Arctic Sea Coast, *Dr. Sutherland!* Prince Edward's Island, *Dr. Jeans!* Halifax, *W. H. H.* Longbranch, New Jersey, *Miss Morris.* *β.* at Monterey, California, *Dr. Coulter!* (v. v.)

Tufts large, bushy and dense. *Fronde*s from 6 to 8 inches long, or more, twice the diameter of human hair, decompoundly branched, generally without a leading stem; the branches alternate or subdichotomous; lesser branches subdistant, alternate or unilateral, multifid. *Internodes* in the middle part of the filament 4-6 times as long as broad, in the branches 2-3 times, in the ramuli very short. *Tubes* 4, broad, with very narrow interspaces. *Conceptacles* urnshaped, with a prominent, contracted orifice, shortly stalked, scattered over the lesser branches and ramuli. *Tetraspores* wider than the places where they occur, immersed in the ramuli in a single row. *Colour* when growing a clear blood-red, becoming dark reddish brown or even black in the herbarium. *Substance* rather rigid, not lubricous. It does not adhere strongly to paper in drying.

β . has a more evident leading stem, with long, subsimple branches set with lateral, multifid, secondary branches about an inch in length, whose divisions are closer together than in the common form. The ramuli, especially the lower ones, are remarkably patent, squarrose, or even revolute. The conceptacles, abundant, on some of Dr. Coulter's specimens, are of the ordinary form, so characteristic of this species.

2. POLYSIPHONIA *formosa*, Suhr; filaments very flaccid, capillary, full red, much branched, branches subdichotomous, long, flexuous, furnished with scattered, spreading, alternate, attenuate, more or less compound ramuli; internodes four-tubed, those of the branches 5-10 times longer than broad, of the ramuli short; conceptacles stalked, urn-shaped, with a projecting, narrow orifice; tetraspores in the ultimate ramuli. *Suhr, Bot. Zeit.* 1831. p. 709. *Harv. Phyc. Brit.* t. 168. *Pol. Hooperi*, Bailey MSS. *Conferva stricta* ? Dillw. t. 40.

HAB. Prince Edward's Island, *Dr. Jeans!* Boston Bay, *Miss E. H. Brewer!* *Dr. Durkee!* New Bedford, *Dr. Roche!* Fort Hamilton and other spots in New York Bay, *Messrs. Walters!* *Hooper!* *Pike!* *Congdon!* *Calverley!* &c. (v. v.)

Tufts dense, very flaccid. *Filaments* finer than human hair, 4-8 inches long, very much branched, decompound, without obvious leading stem, alternately or subdichotomously divided, the penultimate branchlets multifid, and the ramuli frequently secund, attenuate, subulate. In some specimens, when carefully opened out, a leading stem set with alternate decompound branches may be more or less distinctly traced. The lowermost divisions of each branch are generally simple and filiform, the upper ones longer, gradually more compound, alternately pinnated in their upper half. *Apices* frequently multifid and subcorymbose. *Internodes* of the stem 5-10 times as long as broad, of the branches 3-4 times, of the ultimate ramuli very short. *Tubes* 4, broad, with narrow interspaces, and broadish, transparent dissepiments. *Conceptacles* generally stalked. *Colour* when growing, a fine, clear red, becoming darker in the herbarium, and sometimes changing to brown. In fresh water the plant soon gives out a rosy tint. It adheres very closely to paper in drying.

Except in the more slender filaments, softer and more lubricous substance, and rather longer internodes, this species does not differ from the preceding. These characters, which are obvious in the extreme forms of either species, gradually disappear when a great number of specimens from different localities are examined and compared together, and I fear that *P. formosa* can only be regarded as a beautiful variety of *P. urceolata*. Be this as it may, it seems to be the same as Dillwyn's *Conferva stricta*, a name which has many years priority to that here adopted, but which is applicable only to the immature state of the frond. I cannot distinguish *P. Hooperi*, Bail. from the ordinary form.

3. *POLYSIPHONIA Havanensis*, Mont.; filaments short (one to three inches long), dull reddish-brown, very soft and lubricous, densely tufted, rising from creeping filaments, byssoid, four-tubed, pellucidly articulate, alternately decompound, much branched; secondary branches subdistant, often secund; ramuli filiform, fibrilliferous; internodes in the lower part of the stems once or once and a half as long as broad, in the larger branches 4-5 times, in the smaller 2-3 times, and very short in the ramuli; conceptacles . . . ? tetraspores large, subsolitary in the ramuli. *Mont. Nat. Hist. Cubæ*, p. 34, t. 5, fig. 3. *Kütz. Sp. Alg.* p. 818.

HAB. On chalky rocks, near high water mark. Very abundant at Key West in February, *Dr. Wurdeman* (30), *W. H. H., Professor Tuomey* (1). (v. v.)

Tufts very dense, soft and gelatinous, 1, 2, or 3 inches high. *Filaments* rising from matted fibres, much finer than human hair, excessively branched in a manner between dichotomous and alternate. Branches very irregularly divided, repeatedly decompound, their apices not fastigate, the ultimate ramuli either simple or filiform, or more or less cleft at the apex. Branches and ramuli erecto-patent. *Internodes* having the nodes slightly swollen, four-tubed, pellucidly jointed, variable in length; in the lower part of the stem and branches usually very short, scarcely longer than their breadth, in the upper parts gradually longer, but differing greatly in different specimens; in some pretty uniformly twice or at most thrice as long as broad, in others frequently four or five times their breadth, or even of greater length; in the lesser branches and ramuli about twice as long as broad. *Tetraspores* of large size, mostly solitary, sometimes in pairs, much wider than the ramuli in which they are imbedded. *Colour* a deep reddish brown, varying in intensity. In drying, the plant adheres to paper, and gives out a brownish liquid in fresh water.

I am perhaps incorrect in referring my specimens, gathered within eighty miles of Havana, to the *P. Havanensis* of Montagne; but yet, after having inspected a specimen of Dr. Montagne's plant, notwithstanding the differences it shows, I am afraid to propose mine as distinct. The chief differences which strike me are in the internodes, which are uniformly shorter in the Cuban specimen, though not so short as shown in the figure above-quoted. On the Key West specimens I find considerable variation. In the smaller and younger ones the internodes are uniformly short, while in the more luxuriant the internodes of the branches are frequently several times longer than broad; those of the lower stem and upper ramuli being short. Dr. Montagne's specimens appear to me to be undeveloped; mine are of various ages. I hope some algologist may investigate the question at Havana, where alone it can be satisfactorily settled.

4. *POLYSIPHONIA subtilissima*, Mont.; filaments short (2-4 inches long), rising from creeping filaments, densely tufted, dull purplish brown, not gelatinous, capillary or byssoid, articulate, alternately decompound; lesser branches multfid,

attenuate, of unequal height; ramuli filiform; internodes four-tubed, about once and half as long as broad, shorter in the ramuli. *Mont. in An. Sc. Nat. 2d Ser. vol. xviii. p. 199. Kütz. Sp. Alg. p. 804. β. Westpointensis*; more slender and delicate.

HAB. Jackson Ferry, New York, *Mr. Walters and Mr. Hooper*! Little River, Newburyport, *Capt. Pike*! *β. at West Point*, on the Hudson, 60 miles from the sea, *Prof. J. W. Bailey*! (v. s. in Herb. T. C. D.)

Tufts dense, jagged, (not fastigate), 2-4 inches high. *Filaments* very slender, capillary or byssoid, tetragonal, rising from a mat of rooting and creeping fibres, erect, alternately multifid. The main stem rises about half an inch before it branches; thence upwards it throws out several lateral branches, which are simple below, alternately multifid above, the ultimate divisions attenuate, erect or erectopatent, of unequal height, and simple or bifid at the point. The *internodes* in the lower part of the frond are as long as broad, in the branches once and a half as long, and in the ramuli very short. *Apices* often fibrilliferous. The filaments are four angled, and a cross section shows four large tubes surrounding a small cavity. *Colour* a blackish purple, brighter toward the tips. *Substance* flaccid, but not in the least gelatinous. In drying, the plant, notwithstanding its delicacy, does not strongly adhere to paper.

This species was first discovered on the shores of Cayenne, from which locality Dr. C. Montagne has kindly sent me one of his original specimens. This I have compared with those above described, and find them to agree in all respects. The West Point plant, which was first found by Prof. Bailey several years ago, and which has been acknowledged by Dr. Montagne to belong to his species, differs from the Cayenne variety in being of still greater tenuity; a difference which we should naturally anticipate from its place of growth, nearly at the extreme limit of marine vegetation in a tidal river. I have not seen fructification of either kind on any of the specimens.

5. *POLYSIPHONIA secunda*, Mont.; filaments minute (a quarter to half inch) rising from creeping fibres, which are either arched or prostrate, throwing out numerous erect, secund, filiform, subsimple branches; internodes four-tubed, rather longer than their breadth. *Mont. Nat. Hist. Cubæ, p. 33, t. 5, fig. 2. Kütz. Sp. Alg. p. 804.*

HAB. Parasitical on other Algæ. At Key West, often growing on *Digenia simplex*. *W. H. H. (v. v.)*

Tufts spreading over the surface of the plant on which they grow; in my specimens about a quarter inch in height. *Filaments* prostrate, creeping by means of discs issuing from the under surface, throwing up from their upper surface numerous filiform, simple, erect, secund branches. In older specimens these are often deflected or arched, and a second series of similarly secund branches spring from

them, which occasionally have one or two short ramuli. I have not seen greater composition. *Internodes* very short in the prostrate filaments, about once and half as long as broad in the erect branches, appearing three tubed on the latter view, and found by cross section to be square, composed of four large tubes surrounding a rhomboid cavity. *Colour* a dull, dark reddish brown. *Substance* rather rigid. It does not adhere firmly to paper in drying.

This species sometimes intertwines so densely among the ramelli of *Digenia* as to form with them a dense entangled mat, in which other parasites then take root. I have also seen it at Key West on *Laurenciæ*. Montagne's Cuban specimens grew on *Sargassum*.

6. POLYSIPHONIA *breviarticulata*, Ag. tufts dense; filaments rather rigid, tetragonal, rising from a mat of creeping fibres, erect (3-5 inches long), as thick as hog's bristle, not much branched; main stem simple, or once or twice forked, somewhat naked below, beset above with numerous virgate, very erect primary branches, set at intervals with several very slender secondary branches, which are naked below and alternately multifid above; internodes uniformly shorter than their diameter in all parts of the frond, swollen at the nodes; conceptacles ovate, sessile; tetraspores in distorted terminal ramuli. *Ag. Sp. Alg.* 2, p. 92. *Kutz. Sp.* p. 815. *P. physarthra*, *Kg. l. c.* 815. (TAB. XVI. B.)

HAB. Abundant on maritime rocks, near highwater mark, at Key West, *W. H. H.* (No. 19), *Dr. Blodgett* (No. 57), *Dr. Wurdeman* (No. 15 and 16.) Vera Cruz, *Liebman*! (v. v.)

Tufts 3-6 inches high, dense. *Filaments* as thick as hog's bristle, sometimes nearly unbranched, sometimes thrice or four times parted subdichotomously, bare of branches and ramuli below, more or less furnished with alternate branches above. *Branches* but little divided, long and virgate, erect, furnished with several slender secondary branches, of greatly less diameter than the part they spring from. These are simple and naked in their lower half, and alternately multifid above. *Apices* abundantly fibrilliferous when young. *Articulations* in all parts of the frond much shorter than their diameter, visible to the naked eye and then appearing with opaque nodes; under the microscope pellucid, with very wide quadrate tubes and transparent interspaces. A cross section of the stem is square, with four wide tubes surrounding a small central cavity. *Conceptacles* ovate, sessile on the sides of the multifid ultimate ramuli, which on fertile specimens are shorter and more closely branched. *Tetraspores* in the tips of the ramuli. *Colour* a dull reddish brown. *Substance* rigid, not closely adhering to paper.

The Key West specimens agree with one from Vera Cruz mentioned above, but are rather more robust than the Mediterranean form, and more furnished with lateral ramuli. I had at first thought them different, and may perhaps have distributed a few specimens under the MS. name *P. littoralis*, which I gave at Key West to this plant, from its profuse abundance along the shore, near high water

mark. My specimen of *P. physarhra*, Kütz. is very imperfect, but it scarcely seems specifically different from *P. breviarticulata*, as here understood.

Plate XVI. B. *Fig. 1.* Tuft of *POLYSIPHONIA breviarticulata*; the *natural* size. *Fig. 2.* portion of a secondary branch, with its slender multifid tertiary; *fig. 3.* apex of a branch, with *conceptacle*; *fig. 4.* apex in which tetraspores are imbedded; *fig. 5.* base of the stem, to show the manner of rooting; *fig. 6.* roots; *fig. 7.* transverse section of the stem: all the latter figures more or less highly *magnified*.

7. *POLYSIPHONIA Binneyi*, Harv.; filaments rather rigid, setaceous, alternately decompound, much branched; branches elongate, spreading, of unequal length, twice, thrice, or oftener compounded, and at length resolved into capillary, multifid ramuli; nodes swollen, pellucid; internodes four-tubed; those of the stem and branches once and half or twice as long as broad, of the ramuli shorter than their breadth; tetraspore of small size, subsolitary in distorted terminal ramuli. *β.* stem and branches plentifully beset (as if proliferously) with slender, simple, or multifid capillary, lateral ramuli.

HAB. Key West, W. H. H. *β.* at Key West, Mr. Binney! Prof. Tuomey, (3)
W. H. H. Apalachicola, Mr. Loundsbury. (v. v.)

Fronde 2-4 inches high, as thick as hog's bristle, with an ovate outline in the spread of the branches. *Stem* subsimple, closely set throughout with lateral spreading branches, the lowest of which are long, the rest gradually shorter. These primary branches are either subsimple, or twice or thrice alternately decompound, each series of lesser branches gradually more slender, till the frond is resolved into capillary ramuli. In *β.* both stem and branches emit on all sides lateral, simple and hair-like, or multifid ramuli, half an inch long, much more slender than the internodes from which they spring, very irregularly placed, often much crowded, and often laxly scattered. The nodes of the stem and branches are swollen; they are pellucid to the very base of the frond. Internodes of the main divisions at least once and half as long as broad, but generally rather more; those of the younger parts uniformly short. *Tubes* four, very broad. *Colour* a deep brown. *Substance* very tough, long resisting the action of fresh water. It very imperfectly adheres to paper in drying.

Our var. *β.* has a rather different aspect, owing to the profusion of lateral ramuli. It seems, however, to be analogous to similarly proliferous states of various *Ceramia*, &c.

This species is nearly allied to *P. breviarticulata*, but is a more slender plant, with more compound and patent branches, and the internodes of all the principal divisions are uniformly of greater length. In ramification it more nearly resembles *P. Olneyi*, which has however a totally different substance.

8. *POLYSIPHONIA fracta* ; filaments irregularly tufted or bundled together, capillary, rather rigid, divaricately much branched, subdichotomous ; branches distant, spreading at wide angles, beset with scattered, spinelike, horizontal short ramuli ; internodes four-tubed, about equal in length and breadth in all parts of the frond.

HAB. Key West, *W. H. H.* (18), *Dr. Blodgett* (42). (v. v.)

This forms loose, squarrose tufts or bundles. The filaments are rather coarser than human hair, gradually but not greatly attenuated upwards, and irregularly much branched, the main stems dividing subdichotomously. The forkings are distant and spreading, irregularly subdivided. All the branches issue at wide angles, and the larger ones are furnished with numerous, scattered, horizontally patent, thornlike ramuli, about a line in length. The substance is rather rigid. *Colour* a reddish brown. *Stem* square, four-tubed, and dissepiments pellucid in all parts of the frond. It imperfectly adheres to paper in drying.

This has the aspect of *P. subulifera*, but a very different structure. In the characters of the internodes it agrees with *P. breviarticulata*, but differs in the more slender frond and the disposition of the branches and ramuli. *Dr. Blodgett's* specimen is more flaccid than those I collected in February, more densely branched, with the apices fibrilliferous, characters probably dependant on the state of development.

9. *POLYSIPHONIA echinata* ; frond setaceous, rigid, dichotomous ; branches distant, widely spreading, or divaricate, not much attenuated, articulate, four-tubed, beset on all sides with minute, spinelike, horizontal, subulate, simple or bifid ramuli, internodes shorter than their breadth.

HAB. Key West, *W. H. H.* (22). (v. v.)

Fronds three or four inches long or more, as thick as hog's bristle or somewhat thicker, subdichotomously divided ; all the divisions spreading at very wide angles. The forkings are from half an inch to an inch apart, the terminal branchlets generally an inch in length. All the younger parts, at least, are beset at intervals of half a line with minute spinelike ramuli, half a line in length, directed toward all sides, and issuing nearly at right angles with the branch. The articulations are visible in all parts of the stem and branches, uniformly shorter than their breadth, with very wide tubes and swollen dissepiments. The substance is tough and rigid, the membrane of the walls thick, and not readily recovering shape after having been dried. *Colour* a dark brown. It imperfectly adheres to paper.

This resembles *P. fracta* in its ramification, but is much more robust, and the ramuli are more copious, shorter, more compound, and more equally inserted on all sides of the branches.

10. *POLYSIPHONIA hapalacantha*; densely tufted, soft and very flaccid; filaments setaceous and corticate below, much attenuated and articulate upwards, the terminal divisions almost byssoid, sub-dichotomously decompound, fastigiate, the lower axils patent; upper branches less regularly forked; all the branches furnished with minute, simple, scattered, spinelike, quadrifarious ramuli, and copiously clothed with byssoid (deciduous) fibres; articulations in all parts of the frond about as long as broad, four-tubed, those of the larger branches with supplementary cellules.

HAB. Key West, *Dr. Blodgett*! (v. s. in Herb. T. C. D.)

Filaments four or five inches long, branched from the base in a more or less regularly dichotomous order, the lower forks pretty regular, the upper, by the frequent suppression of an arm, subalternately decompound. The filaments are greatly attenuated upwards, the lower parts being thicker than hog's bristle, the upper branches much finer than human hair. *Axils*, especially the lower ones, patent. *Spine-like*, simple ramuli, one or two lines in length, and spreading to all sides, are freely scattered over the segments at distances of a line or two. Our specimens are copiously fibrilliferous. The articulations are uniformly short; those of the upper divisions marked with two broad tubes, those of the lower successively coated with secondary cells, but not obliterated. *Colour*, when dry, a Vandyke brown. *Substance* very soft. It closely adheres to paper.

11. *POLYSIPHONIA Gorgoniæ*; filaments subsolitary, short (an inch high), flaccid, flabellately branched, irregularly dichotomous below, alternately decompound above, attenuated, all the divisions rather patent; ramuli of unequal length (not fastigiate); internodes near the base very short, in the larger divisions once and half as long as broad, in the smaller about twice as long as broad, four tubed; dissepiments pellucid; conceptacles globose, on short stalks, abundant.

HAB. Parasitical on various corals. Key West, *W. H. H.* (25) *Dr. Blodgett*, 40. (v. s. in Herb. T. C. D.)

Filaments rising from discoid bases, scattered, rarely somewhat tufted, an inch high, subsetaceous below, rapidly diminishing in thickness upwards, forking at two or three lines from the base, and afterwards twice or thrice forked, the upper divisions irregularly multifid and attenuated to a byssoid fineness. All the divisions are patent and the branches open out like a fan in water. The dissepiments are pellucid in all parts. The internodes four-tubed, and four-angled; those in the lower part of the stem shorter than their breadth, of the branches once and half to twice as long as broad, in the ultimate ramuli very short. *Conceptacles*, which are plentifully borne on some specimens, globose, but depressed vertically or oblate, very full of spores, on short pedicels of the lesser branches or subsessile. *Colour* a pale ochrey brown, darker towards the tips. *Substance* soft and flaccid. It adheres to paper in drying. This is a very pretty little species, distinct from any of

the North American ones. I found it on the purple, whip-like *Gorgonia* so common at Key West.

12. *POLYSIPHONIA Olneyi*, Harv.; tufts dense, silky, flaccid, purple-brown; filaments capillary below, byssoid above, decompound, excessively branched; branches very patent or divaricate, many times compounded, gradually attenuated, more or less beset with scattered, slender, spinelike ramuli; articulations very variable in length, in the larger branches from two to six times, in the lesser branches and ramuli once and half to twice as long as broad; conceptacles ovate, subsessile; tetraspores in distorted ramuli. *Harv. in Olney's List of Rhode Island Plants, Proceed. Prov. Frank. Soc., Apl. 1847. (TAB. XVII. B.)*

HAB. On *Zostera*, &c. Halifax, *W. H. H.* Nantucket, *Dr. Durkee.* Providence, Rhode Island, (1846) *Mr. S. T. Olney.* Greenport, Long Island, *Prof. Bailey and W. H. H. (v. v.)*

Tufts from three to five inches long, dense, soft and silky. *Filaments* as thick as human hair, or sometimes twice as thick at the base, where they are also of a firm substance; soon becoming thinner, and passing off above into excessively fine, byssoid ramuli, much branched from the base without regular order; the branches many times compounded by alternate or unilateral ramification. *Branches* more or less furnished with lateral spinelike, scattered ramuli, from a line to a quarter inch in length. The lower divisions of the stem and branches are very patent, sometimes widely divaricating, the upper more erect, with narrower angles. A cross section of the stem, or of one of the larger branches near the base, shows four large primary tubes surrounding a central cavity, and four secondaries of small size alternating with them. The *internodes* are very variable in length in different specimens; those of the stem and larger branches are frequently not more than twice as long as broad, but are sometimes four or even six times their length; those of the lesser branches and ramuli are more uniformly short. *Conceptacles* ovate, abundantly scattered over the lesser branches. *Colour* a rich purple brown, more or less intense. *Substance* soft and lubricous. It adheres very closely to paper in drying.

This species has many characters in common with the following, but is a more slender plant, much softer and more lubricous in substance, with longer internodes, longer, more filiform and much less abundant ramuli, &c. It must be allowed, however, that most of these characters are variable. The length of the internodes is particularly so, the first specimens which I received from Mr. Olney, and on which I founded the species, having them uniformly short; while others, collected in the same locality, but at a different season, have them often of the great length shown at fig. 5.

Plate XVII. B. *Fig. 1*, a frond of *Polysiphonia Olneyi*, removed from the tuft, the *natural* size. *Fig. 2*, part of a branch from the same; *fig. 3*, a small portion of the branch with ramulus; *fig. 4*, part of a branch from another specimen; *fig. 5*, one of the longer internodes from the same; *fig. 6*, a conceptacle; *fig. 7*, transverse section of the stem; the latter figures more or less *magnified*.

13. *POLYSIPHONIA Harveyi*, Bail. ; tufts globose and bushy ; filaments rather rigid, setaceous, divaricately much branched ; branches alternately decompound, very patent, often angularly bent, set throughout with more or less numerous, short simple, or forked, spinelike ramuli ; internodes short in all parts of the frond, once or twice as long as broad in the branches, much shorter than their breadth in the lesser divisions and ramuli, four-tubed ; dissepiments pellucid ; conceptacles broadly ovate near the tips of the branches ; tetraspores in distorted ramuli. *Bail. in Sillim. Journ.*—(Tab. XVII. A.)— β *arietina* ; very squarrose, the ramuli strongly revolute and curled. *Pol. arietina*, *Bail. MS.*

HAB. On *Zostera* and other marine plants. Boston Bay, *Dr. Durkee*, *Mrs. Mudge*, *Mr. Girard*, etc. Abundant in Long Island Sound ; Stonington, *Prof. Bailey* (1846) ; Greenport, Long Island, both varieties, *Prof. Bailey and W. H. H.*

This forms globose, squarrose, loose tufts, which do not collapse, when lifted from the water, if the plant be quite fresh. *Filaments* often, but not always, as thick as hog's bristle at the base, attenuated upwards, excessively branched and bushy ; the branches dividing repeatedly without much order, alternate or secund, widely spreading, often much divaricated. Lesser branches variable in number and in subdivision, sometimes very few and little divided, sometimes numerous. *Ramuli* generally very abundant, half a line to a line long, spinelike, simple or forked, subulate, very patent, sprinkled irregularly over all the branches, large and small. *Internodes* generally very short in all parts of the stem and branches, but variable in length in different specimens and at different ages. Those of the lower part of the stem show, on a cross section, four primary and four small secondary external tubes. Those of the branches are sometimes shorter than their breadth, sometimes twice as long ; in the latter case the coloured tubes are often spirally twisted. The pellucid integument of the filament is thick, and the nodes are generally swollen. *Conceptacles* broadly ovate, usually placed near the ends of the branches. *Tetraspores* of small size, in distorted ramuli. *Colour* a very dark, purplish brown. *Substance* firm, rigid. In drying, the plant adheres, but not firmly, to paper.

β is smaller, and still more squarrose, with its spinelike ramuli strongly recurved or rolled back like a "ram's horn." I think, however, that I have traced it, through numerous specimens, into the ordinary form. Sometimes the frond is much more densely branched than our figure, taken from one of the original specimens, shows. The obvious characters of the species are the abundant thornlike ramuli and short joints.

This plant is common in various places in Long Island Sound. While dredging with Professor Bailey in Peconic Bay, our exclamations of delight on hauling up some specimens of it attracted the notice of one of our boatmen, who took up a handful of what we seemed so eagerly hoarding, but immediately threw it down with a "Pooh ! that's what we call 'nigger-hair.'"

Plate XVII. A. *Fig. 1*, frond of *POLYSIPHONIA Harveyi*, the natural size. *Fig. 2*, apex of a branch ; *fig. 3*, ramulus with tetraspores ; *fig. 4*, a tetraspore ; *fig. 5*,

portion of a branch, with ramuli and a conceptacle ; *fig. 6*, transverse section of the stem ; all the latter figures more or less highly *magnified*.

**** Stem and larger branches inarticulate, more or less completely coated with small, irregular cellules. Ramuli articulate. (Sp. 14—17.)**

14. *POLYSIPHONIA ramentacea*; stem robust, dendroid, inarticulate, internally four-tubed, irregularly much branched; branches spreading on all sides, alternately divided; lesser branches rod-like, simple, set throughout with numerous, short, setaceous, spine-like, simple or forked, articulate ramuli; internodes of the ramuli shorter than their breadth, marked with two or three quadrate cells; conceptacles ovate, borne near the tips of the ramuli. (TAB. XVI. A.)

HAB. On corals, &c. Key West, *W. H. H., Dr. Blodgett.* (v. v.)

Root discoid. *Stem* solitary, four or five inches high, twice or thrice as thick as hog's bristle, gradually attenuated upwards, soon forking, and afterwards repeatedly divided in an irregularly alternate manner, the whole system of branches forming a tree-like frond. The larger branches spread towards every side, and are furnished with numerous lateral, secondary branches, scattered or crowded, and either simple or having another series of similar branches, all tapering to a fine point. The stem and branches are alike beset, at distances of half a line or less, with slender, simple or forked, bristle-shaped, quadrifarious ramuli, a line or two in length. These ramuli are pellucidly articulate, the articulations exceedingly short, with sub-quadrate tubes. The stem and branches are opaque, tessellated with small irregular cells; a transverse section showing four primary tubes, with an external coating of greater or less thickness formed of small cells. *Conceptacles* ovate, small, sessile near the tips of the ramuli. *Antheridia* ovato-lanceolate, densely tufted at the apices of the ramuli. *Colour* a dull reddish brown, darkening in drying. *Substance* cartilaginous, but soft. In drying, it adheres pretty closely to paper.

Of this apparently rare species, I collected only a solitary specimen during my visit to Key West. It is abundantly unlike any other North American species, but nearly allied to *P. flexella* of the Mediterranean. My specimen, however, differs from any that I have seen of *P. flexella*; it recovers better after having been dried, the articulations of the ramuli are more distinct, and the byssoid fibres far less copious.

Plate XVI. A. *Fig. 1.* *POLYSIPHONIA ramentacea*; the *natural* size. *Fig. 2*, apex of a branch; *fig. 3*, portion of a ramulus; *fig. 4*, transverse section of a branch; *fig. 5*, lateral view of a small portion of the same, to show the surface cells; the latter figures more or less highly *magnified*.

15. *POLYSIPHONIA elongata*, Grev.; stems robust, cartilaginous, irregularly branched, decomposed, best, especially toward the end of the branches, with slender, closely set, alternately multifid ramuli, which taper to the base and apex; articu-

lations of the stem and branches areolated with small, irregular cells, more or less obsolete; of the ramuli once and a-half or twice as long as broad, marked with numerous (secondary) tubes and small cells; primary tubes four. *Ag. Sp. Alg.* vol. 2. p. 82. *Kütz. Sp. Alg.* p. 828. *Harv. Phyc. Brit.* t. 292 and 293.

HAB. Boston Harbour in various places, rare? Lynn Beach, *Dr. Durkee*. Germantown, *Miss E. H. Brewer*. (v. v.)

Root a large scutate disc. *Fronde*s mostly solitary, 6-12 inches long, cartilaginous, firm, as thick as packthread at the base, gradually attenuate upwards, decomponently branched in a manner between dichotomous and alternate; the branches sometimes bare of ramuli, long and twiggy; and sometimes emitting, especially from their upper half, broad pencils of multifid, rosy or blood-red flaccid ramuli. Internodes obscurely visible in all the older parts of the frond, distinctly marked in the ramuli alone, about once and half as long as broad, sometimes a little longer, netted over with irregularly shaped, polygonal cells. A cross section shows four primary tubes of a large size, protected externally by several rows of irregularly placed cells, which are gradually smaller to the circumference. *Conceptacles* ovate, scattered over the branches. *Tetraspores* in the distorted tips of the flaccid ramuli. *Colour* red-brown in the stem, rosy or blood-red in the ramuli. In drying, the stem scarcely adheres to paper, except after strong pressure, but the ramuli, when present, adhere very closely.

A most variable plant in aspect. Specimens of the first year's growth have a very few flaccid ramuli scattered along the twiggy branches. In winter these, as well as the ends of the branches, fall away, leaving a truncated or somewhat pollarded frond. In the following spring, such as survive throw out a profusion of byssoid and multifid ramuli, which are peculiarly abundant and dense round the wounded parts.

16. *POLYSIPHONIA fibrillosa*, Grev.; pale straw-colour or brownish; stems inarticulate, opaque, marked with sinuous veins, robust, alternately branched; branches spreading, resembling the stem, but less opaque, articulated near the ends, sub-simple, thickly set with very slender, articulated, finely divided, short ramuli, whose tips are copiously fibrilliferous; internodes of the ramuli, rather longer than broad, bi-tri-striate; primary tubes four, in the stem coated with a thick layer of cells; conceptacles ovate; tetraspores large, in the terminal ramuli. *Ag. Sp. Alg.* vol. 2. p. 78. *Kütz. Sp.* p. 827. *Harv. Phyc. Brit.* t. 302.

HAB. Newport, Rhode Island, *Prof. Bailey*. Lynn, Massachusetts, and Peconic Bay, *Mr. Hooper*. (v. v.)

Tufted. *Stems* once or twice as thick as a hog's bristle, alternately much branched, the lateral branches spreading irregularly on all sides, repeatedly compound; the main stem and principal and lesser branches opaque and inarticulate,

coated with oblong, sinuous, irregular cells. The smaller branches are gradually resolved into alternately multifid, articulated ramuli. *Internodes* of the ramuli about as long as broad, or a little longer. A cross section of the stem shows four primary tubes, surrounded by many rows of cells, smaller gradually to the circumference; the four secondary tubes (alternating with the primaries) large. Ends of the branches and ramuli with abundant byssoid fibrils. *Conceptacles* broadly ovate, subsessile. *Colour* a dull, pale red brown. *Substance* soft, soon decomposing. In drying, it adheres very closely to paper.

This scarcely differs from the following except in the duller colour, less divided ramuli, and shorter internodes. This is the plant published as *P. Brodiaei* in Prof. Bailey's list. I have examined his specimen and find but four primary tubes in the stem; not six, as in *P. Brodiaei*.

17. *POLYSIPHONIA violacea*, Grev.; brownish red or purple; stem inarticulate, marked with irregular cells, robust, alternately branched, decomposed; branches quadrifarious, repeatedly divided, bushy or feathery, the ultimate ramuli exceedingly slender, alternately multifid, fibrilliferous; internodes of the ramuli bistriate, two to four times as long as broad; primary tubes four, in the stem coated with a thick layer of cells; conceptacles ovate, stalked or subsessile; tetraspores in swollen submoniliform ramuli. *Ag. Sp. Alg. vol. 2, p. 76.* *Kütz. Sp. Alg. p. 826.* *Harv. Phyc. Brit. t. 209.*

β flexicaulis; stem and branches more slender than common, angularly bent, excessively divided, the lesser divisions very patent and frequently secund; internodes of the ramuli rather longer than usual.

HAB. On *Zostera*, &c., frequently in deep water, beyond tide marks. Penobscot Bay, Maine, *Mr. Hooper*. Boston Bay, *Mr. G. B. Emerson*, *Dr. Durkee*, *Capt. Pike*. New Bedford, *Dr. Roche*, *Mr. Congdon*. Seaconnot, *Mr. Congdon*. *β*. Prince Edward's Island, *Dr. Jeans*. Profusely common in Halifax harbour in July, *W. H. H.* (v. v.)

Subsolitary, or loosely tufted. *Stem* 6—12 inches long, or more, as thick or twice as thick as hog's bristle below, gradually attenuated upwards, simple or but slightly divided, set throughout with lateral, spirally inserted branches, the lowest of which are longest, the rest gradually shorter upwards. *Branches* elongate, bearing a second or third series of similar but shorter branches, the last of which are alternately multifid, and resolved into excessively slender, finely divided ramuli, the minute division of which, in luxuriant specimens, gives the plant a feathery aspect. The stem and larger branches are opaque, marked with numerous, irregularly shaped, veiny cells, without apparent articulation, the nodes being hidden under the cellular coat. The lesser branches and ramuli are pellucidly articulate, the internodes of the former being three or four times, of the latter about twice as long as broad. *Conceptacles* generally pedicellate. *Colour* varying from brown to purple, often becoming brighter after the plant has been dried. *Substance* of the

stem cartilaginous, but tender ; of the branches and ramuli very flaccid, soft and lubricous. It adheres most closely to paper in drying.

Var. β , which I dredged in great profusion at Halifax harbour, where, in July and August, it is one of the most characteristic plants, is often two feet long or more, and excessively and almost intricately branched. The main stem and branches are remarkably flexuous, bent from side to side in a zigzag manner, and their lesser divisions are very frequently secund. Except in these characters, which I do not think of specific importance, this variety does not differ from the ordinary form.

SUB-GENUS 2. POLYSIPHONIA. Primary tubes more than four. (Sp. 18—28.)

18. POLYSIPHONIA *variegata*, Ag. ; tufts dense, brownish purple or greenish ; filaments setaceous and rigid below, capillary above, dichotomo-multifid, the lower axils very patent ; branches somewhat zigzag, elongated, furnished with lateral, capillary, very flaccid, multifid, purple ramuli ; internodes near the base shorter than their breadth, once and half to twice as long as broad in the branches and ramuli, three banded ; tubes six ; conceptacles ovate, short-stalked. *Ag. Sp. Alg.* 2. p. 81. *J. Ag. Alg. Medit.* p. 129. *Harv. Phyc. Brit.* t. 155.

HAB. On *Zostera*, &c. Annual. Massachussetts Bay, *Dr. Durkee*, *Mr. Pike*. Peconic Bay, *Prof. Bailey* and *W. H. H.* Several places in Long Island Sound. New York, *Mr. Hooper*, *Calverley*, &c. Sullivan's Island, Charleston, *Prof. Gibbs*, *W. H. H.* &c. (v. v.)

In fine tufts. *Filaments* as thick as hog's bristle below, capillary and byssoid above, two to ten inches long, dichotomous below, repeatedly forked, alternately or irregularly decompound above ; the lower divisions spreading with very wide angles and subdistant, the upper gradually more erect. In some specimens the whole frond has a flabelliform outline and is pretty equally dichotomo-multifid, none of the pencils of ramuli crowding on each other ; in others the principal stems are a few times divided, nearly flexuous or zigzag, and alternately set with pencils of closely dichotomous, crowded, subfastigate ramuli. *Internodes* visible to the base of the frond, and, except near the base where they are very short, pretty regularly once and half or twice as long as broad, showing three tubes on the lateral view, and a circle of six (rarely seven) round a small central cell, when cut across. No secondary tubes except toward the base of old stems. *Apices* attenuate, with very short joints. *Colour* a dark, purple brown or blackish purple, becoming a brighter purple after having been dried. The substance is soft and lubricous, but not very gelatinous, and the plant adheres closely to paper in drying. *Conceptacles* broadly ovate or subglobose, widemouthed, pedicellate, scattered over the branches.

This plant, though in some respects variable, has a peculiarity of aspect which

renders it, after it has once been seen, easily recognised in the several varieties it assumes. It is the only species yet found in Charleston Harbour, where in January and February it is very abundant. It extends north as far as Boston, where it is a summer plant. In Europe it is a characteristic Adriatic species, and is found along the Atlantic coast as far as the south of England.

19. *POLYSIPHONIA parasitica*, Grev. ; filaments slender, rigid, full red, decom-pound-pinnate, distichous ; branches bi-tri-pinnate ; pinnules closely set, alternate, erecto-patent, awl shaped, acute ; internodes about as long as broad, about four-banded ; dissepiments hyaline, wavy ; tubes about eight ; conceptacles ovate, on short stalks ; tetraspores immersed in swollen pinnules. *Grev. Fl. Edin. p. 309. Harv. Phyc. Brit. t. 147. Ag. Sp. Alg. 2, p. 103. Kütz. Sp. Alg. p. 803.*

HAB. Providence, Rhode Island (fide Sp. in Herb., Hooper).

One to three inches high, distichous, repeatedly pinnate. *Colour* when growing a clear lake-red, becoming brownish in drying. It imperfectly adheres to paper.

Apparently a rare species in America. I have only seen a solitary specimen in the collection of Mr. Hooper of Brooklyn. It is a beautiful plant resembling a miniature *Ptilota* in outward aspect.

20. *POLYSIPHONIA Pecten Veneris* ; small (1-2 inches high), capillary, alternately branched ; branches flexuous, sometimes many times compound, spreading or reflexed ; lesser branches pectinated on one side with secund, bristle-shaped, short ramuli, issuing from every node ; internodes nine or ten tubed, about once and half as long as broad, those of the ramuli shorter ; tetraspores immersed in the ramuli ; conceptacles ovato-rostrate, on long peduncles ! Var. *α*. much branched, the comblike branches strongly recurved. (Tab. XVI. C.) Var. *β*. less branching, the comblike branchlets elongate, straight or nearly so. (Tab. XVI. D.)

HAB. On small Algæ and corallines. Key West, *W. H. H. (20). Dr. Blodgett, (70).* Pine Islands, *Prof. Tuomey (26).* (v. v.)

Filaments decumbent at base and creeping, then erect, capillary or subsetaceous, much branched, distichous. *Branches* alternate, flexuous, spreading at wide angles, repeatedly divided, the successive divisions usually secund. All the lesser branches and portions of the branches and stem are furnished, at intervals of less than a quarter of a line, with secund, subulate, or bristle-shaped ramuli about a line in length, so that each penultimate branchlet with its ramuli resembles a miniature comb. These little combs in the larger and more branching specimens are generally strongly reflexed, the ramuli curving in an opposite direction. A transverse section of the stem shows nine or ten tubes. The internodes are rather longer than

broad in the ramuli, and once and half to twice their breadth in the branches. *Conceptacles* ovato-urceolate, acuminate, or produced at the orifice into a long beak, borne on peduncles longer than themselves, often twice as long, originating on the principal branches of the frond, and more than twice the diameter of the ordinary ramuli. *Tetraspores* immersed in the ramuli. *Colour* a brown red of variable intensity; in old specimens the branches are sometimes colourless while the ramuli are strongly coloured. *Substance* soft. It adheres, but not very strongly, to paper in drying.

The smaller and less branching specimens resemble *P. obscura*, but are much more delicate; the larger are quite unlike any other North American species. Since our figure was prepared I have received from Dr. Blodgett specimens bearing conceptacles. These are very curious, shaped like those of *Dasya elegans*, and borne on still longer peduncles.

PLATE XVI. C. *Fig. 1.* POLYSIPHONIA *Pecten Veneris*; the natural size. *Fig. 2.* part of a branch *magnified*; *fig. 3.* ramulus, with tetraspores, more highly *magnified*. D. *Figs. 1 and 2,* var. β . the natural size. *Fig. 3,* part of a branch; *fig. 4,* small piece of the same and ramulus with tetraspores; *fig. 5,* cross section of a branch; the latter figures more or less *magnified*.

21. POLYSIPHONIA *exilis*; filaments densely tufted, creeping, afterwards ascending or suberect, furnished with a few distant, secund, unequal, filiform ramuli; internodes shorter than their breadth in all parts of the frond; tubes nine; tetraspores in the ramuli.

HAB. Key West, W. H. H. (24) Dr. Blodgett, (v. v.)

Densely tufted. *Filaments* matted together at base and there attached by lateral rooting fibres; afterwards ascending or sub-erect, about an inch in length or rather more, ultra-capillary, generally simple, furnished at short intervals with numerous very unequal, secund ramuli, long and short often indiscriminately ranked together, the ends of the filaments generally bare. *Internodes* very short, about half as long as broad, with pellucid dissepiments. A cross section shows nine tubes. *Tetraspores* in distorted ramuli. I have not seen conceptacles. *Colour* a dark brown red, becoming much browner in drying. *Substance* coarse and rather rigid. It imperfectly adheres to paper in drying.

Allied to *P. obscura*, Ag.; but more robust, and yet with fewer and broader tubes. I also collected at Key West one or two specimens of a *Polysiphonia* nearly allied to this, differing in being less robust, less branching, having longer internodes and a rather brighter colour. As the specimens are not in a very good state, I am unwilling to give them a name at present, and thereby add to the sufficiently numerous list of bad species in this genus.

22. *POLYSIPHONIA atrorubescens*, Grev. ; filaments setaceous, erect, sparingly or much branched, dark red, somewhat rigid ; branches long, alternate, very erect, alternately decompound, naked or furnished with short, simple or multifid, scattered, acute ramuli, which taper to the base and apex ; internodes of the branches twice or thrice as long as broad, of the ramuli shorter than their breadth, twelve tubed, the tubes frequently spirally twisted ; conceptacles broadly ovate or sub-rotund, sessile, tetraspores in the ramuli. *Ag. Sp. Alg.* vol. 2. p. 64. *Harv. Phyc. Brit.* t. 172. *Pol. Agardhiana*, Grev. *Scot. Crypt. H.* t. 210. *Conferva atrorubescens*, Dillw. t. 70.

HAB. Little Compton, *Dr. Durkee*. Longbranch, New Jersey, *Miss Morris*, (v. v.)

Stems densely tufted, two or three inches long in our American specimens, as thick as hog's bristle, irregularly branched, not much tapered upwards ; branches long and virgate, sub-simple, very erect, here and there furnished with a few alternately multifid ramuli, which taper to the base and apex, and are thus spindle-shaped. Larger specimens are often more compound. *Internodes* about twelve tubed, twice as long as broad in the branches, shorter in the ramuli and toward the base of the stem, multistriate, the tubes very frequently, but not always, spirally twisted. *Conceptacles* broadly ovate, wide-mouthed, sessile near the ends of the ramuli. *Tetraspores* of large size, in the distorted ramuli. *Colour* when growing, a full deep-red, changing to reddish-brown in the herbarium. *Substance* rather rigid. It does not strongly adhere to paper in drying.

Miss Morris's specimens are in fruit, of both kinds, and have all the usual characters of the European plant, from which they differ merely in being less luxuriant. Dr. Durkee's are not fully grown, and the tubes are straighter than usual. I see no sufficient reasons for doubting that both belong to the same species.

23. *POLYSIPHONIA Californica*; flaccid, capillary, densely tufted ; filaments dividing near the base into subsimple, elongate, flexuous branches, which are naked below, and set with short, alternate, secondary branches above ; secondary branches pinnate or bipinnate, the pinnules tapering to the base and apex ; internodes many-tubed, those of the branches nine or ten times, of the ramuli about twice as long as broad.

HAB. Golden Gate, California, *Captain N. Pike*. (v. s. in herb. T. C. D.)

Densely tufted. *Filaments*, so far as I can judge from the imperfectly extricated specimens before me, divided near the base into several long branches. These branches are four or five inches long, simple or nearly so, flexuous, capillary, bare of lesser branches below and furnished above, for two thirds of their length, with lateral, secondary branches from a quarter inch to an inch in length, and at distances apart varying from nearly an inch to one or two lines ; the lowest most distantly placed. The simplest of the lateral branches are naked for more than half their length and pinnated in the remaining portion ; the more compound are

similar but bipinnate, each of their pinnæ being naked below and pinnulate above. The pinnules are very erect and taper to the base and apex. The tubes in the specimen examined are nine or ten in the stem. The internodes are distinctly visible in all parts of the frond; those of the main branches are very many times longer than broad, and have the tubes often spirally twisted; those of the smaller branches and pinnæ are uniformly short, once and a half to twice as long as broad; and those of the pinnules are about as long as their breadth. The substance, though tenacious, is very flaccid. The colour, probably full red in the recent plant, is a dark red brown in the dried specimen. In drying, it does not adhere very closely to paper.

This is allied in many respects to *P. atrorubescens*, from which it differs in tenuity and in general aspect, as well as in the much greater length of the internodes of the larger branches. These latter characters connect it with *P. tenuistriata* of the Southern Ocean, and perhaps future observations may oblige us to unite it to that species; but at present we have not evidence to warrant our doing so.

24. *POLYSIPHONIA nigrescens*, Grev.; frond robust, rigid and rough with broken branches below, flaccid much branched and bushy above; branches alternate, decompound pinnate; ramuli distant, elongate, awl-shaped, alternate, the upper ones pinnulate near the tips; internodes of the branches rarely shorter than their breadth, often once and half to twice or four times as long as broad, multistriate; tubes from twelve to twenty; conceptacles ovate, sessile or nearly so. *Ag. Sp. Alg.* 2, p. 69. *Kütz. Phyc. Gen. t.* 50, f. 4. *Sp. Alg.* p. 813.

Of this most variable plant I have received the following forms from America:—

fucoïdes; robust, excessively branched and bushy; branches sub-spirally inserted, many times pinnated, the lesser branches sub-bipinnate, fastigiate and sub-corymbose; pinnules naked below, pinnulate above; internodes of the branches once and half to twice, of the ramuli once and half as long as broad; tubes of the stem varying from twelve to twenty. *Pol. nigrescens*, *Harv. Phyc. Brit. t.* 277. *P. fucoïdes*, *Grev. Edin. p.* 308. *Conferva fucoïdes*, *Dillw. t.* 75. *E. Bot. t.* 1743.

β. *affinis*; robust, elongate, repeatedly pinnate but rather laxly branched, the principal branches naked below, decompound pinnate above; the lesser branches somewhat fastigiate and corymbose; internodes of the branches three or four times, of the ramuli once and half to twice as long as broad; tubes 15-16. *Pol. affinis* *Moore*; *Harv. Phyc. Brit. t.* 303.

γ. *plumosa*; stem setaceous, undivided, pinnated with lateral, alternate or secund, sub-distant, decompound branches; branches lanceolate in outline, three or four times pinnate, plumose, the apices not fastigiate; ramuli very slender, erecto-patent; internodes of the branches 2-4 times, of the ramuli once and half to twice as long as broad; tubes seventeen or eighteen.

δ. *gracillima*; stem setaceous, undivided, pinnated with capillary elongate

branches ; branches bi-pinnate, both pinnæ and pinnules distant, very slender and irregularly placed ; internodes of the branches 4–8 times, of the pinnules twice or thrice as long as broad ; tubes twelve.

ε. *tenuis* ; stem setaceous, decompound-pinnate ; branches sub-distichous, ovate in outline, 3–4 times pinnate ; the pinnæ and pinnulæ patent and rather distant, not fastigiate ; internodes of the pinnæ 3–4, of the pinnules 2–3 times as long as broad ; tubes fifteen.

Var. ζ. *Menziesii* ; setaceous, alternately branched, distichous ; branches virgate, bi-pinnate ; pinnæ sub-distant, pinnulæ subulate, the lowermost squarrose or revolute, simple, the upper erecto-patent, simple or alternately multifid ; internodes of the branches twice or thrice as long as broad, of the ramuli shorter than their breadth ; tubes twelve or thirteen.

η. *disticha* ; stem setaceous, decompound-pinnate, distichous ; branches bi-tripinnate, with a subdefined, oblong or ovate outline, the pinnæ and pinnulæ remarkably patent ; internodes of the pinnæ rather shorter than their breadth, of the pinnules as long as broad ; tubes eleven or twelve.

θ. *Durkeei* ; robust, compressed, decompound-pinnate, distichous ; branches with a definite, oblong outline, bi-tripinnate ; pinnæ naked at base, pinnulate above, pinnules erect ; all the internodes much shorter than their breadth. *Pol. Durkeei*. Harv. MSS. (TAB. XVII. C.)

HAB. In rock pools between tide marks, and in deep water, attached to rocks and shells, &c. Perennial. Var. α. *Sitcha*, *Barclay* ! Prince Edward's Island, *Dr. Jeans*. Nahant, *W. H. H.* Newburyport, *Miss Townsend*. Staten Island, *Prof. Bailey*. Red Hook and Fort Hamilton, *Messrs. Hooper, Pike, Walters, &c.*, *W. H. H.* β. Halifax, *W. H. H.* γ. New Bedford, *Dr. Roche*. δ. Yellow Hook, New York, *Mr. Walters*. ε. Ship Anne Point, *Messrs. Walters and Hooper*. Boston Bay, *Capt. Pike*. New Bedford, *Dr. Roche*. ζ. West Coast, *A. Menzies, Esq.* (1788). η. Newport, *Mr. Olney*. Long Island Sound, *Capt. Pike*. Fort Hamilton, *Messrs. Hooper, Walters, Congdon*. θ. Germantown, *Dr. Durkee*. New Haven, *Dr. Durkee and Mrs. Babcock*.

Some of the above varieties are so unlike the normal form of this species (our var. α. *fucoides*), that were there not intermediate states they might readily pass for distinct species. The number of tubes in the stem is extremely variable in different specimens, even where there is no other difference. In some I have found them as few as eleven, in others as many as eighteen ; the more common numbers being twelve and fifteen. The length of the internodes is more constant in the several varieties, when the penultimate divisions of the frond are compared. The best general marks for the species are its decompound, pinnate branching, penultimate ramuli, naked below and pinnulate above the middle, and many tubed internodes of moderate length.

Var. α. *fucoides*. Stems 6–12 inches long, as thick or twice as thick as hog's bristle, rigid below, flaccid above, many times decompound ; the lesser branches very dense and bushy, of equal length ; the ultimate ramuli very erect, fastigiate,

crowded toward the ends of the branches. *Conceptacles* scattered on the ramuli. *Internodes* seldom more than twice as long as broad, often shorter. *Tubes* 12-13-15 18-20 in different specimens. Lower part of the stem somewhat opaque, partially coated with surface cells. *Colour* a blackish purple. *Substance* tough. A common North American form.

Var. *β. affinis*. *Stems* 12-18 inches long, thicker than hog's bristle, more distantly branched than var. *α*, with the branches more naked in their lower half. This variety, which I believe always grows in deep water, beyond tide marks, is further remarkable for the greater length of internodes of the stem.

Var. *γ. plumosa*. *Stems* 8-10 inches long, as thick as hog's bristle, undivided, but set throughout at short distances with lateral branches, the lowest of which are longest, the upper gradually shorter, giving the general frond a pyramidal outline. These branches are lanceolate in outline, slender, and many times pinnated, the decompound ramuli being capillary and almost byssoid. *Internodes* of the lesser branches thrice or four times as long as broad; opaque towards the base of the stem. *Colour* a purplish brown. *Substance* soft and flaccid. In drying, all parts, except the base of the stem, adhere closely to paper.

Var. *δ. gracillima*. *Stem* 8-10 inches long, scarcely as thick as hog's bristle below, capillary above, laxly set with distantly pinnated, slender, capillary branches. *Ramuli* but slightly compound. *Internodes* of the branches very long; from five to six or eight times as long as broad, of the lesser branches shorter. Of this variety I have seen but a solitary specimen, which is so unlike the ordinary state of the species, that I had at first considered it specifically distinct; but it seems, on closer examination, to be intermediate between the preceding and following forms. The great length of the internodes is, however, a striking peculiarity.

Var. *ε. tenuis*. *Stem* 6-10 inches long, as thick as hog's bristle, attenuated upwards, decompound pinnate; branches closely set and three or four times compounded, the pinnæ and pinnulæ sometimes subdistichous, sometimes spirally spreading. *Internodes* of the branches 4-5, of the pinnæ 3-4, of pinnules thrice as long as broad. *Colour* a blackish brown. *Substance* flaccid, but not lubricous. In drying, it does not strongly adhere to paper. Not an uncommon American form. It has the aspect of var. *α*, but is much more slender, and has much longer internodes.

Var. *ζ. Menziesii*. *Stems* 3-4 inches high, as thick as horse hair, distantly branched; branches alternate, virgate, naked below, or with a few distant squarrose or revolute simple ramuli, bipinnate above, narrow oblong in circumscription, distichous. *Pinnæ* half an inch long, the lowest pinnulæ frequently recurved or curled, the upper erectopatent. *Tubes* 13. *Colour* dark brown. Characterised by the squarrose or revolute ramuli. The specimens described are marked "*Rhodomela floccosa*" in the Menziesian Herbarium. A specimen of the true *R. floccosa*, which was first discovered by Mr. Menzies, is fastened on a separate sheet. Our plant is much smaller and more slender, and the microscopic analysis very different. Though peculiar as a form, I do not think it can be separated by essential characters from *P. nigrescens*.

Var. *η. disticha*. *Stem* as thick as hog's bristle, 4-6 inches long, distichously

branched ; the main stem and branches somewhat angularly bent. All the divisions patent, and all the internodes short. *Substance* rigid. *Colour* very dark. This variety is readily known by its patent, distichous branches, rigid substance, and internodes uniformly shorter than in the preceding forms, with which it seems to connect the following.

Var. *θ. Durkeei*. *Stem* 2-3 inches high, thicker than hog's bristle, compressed (?), distichously branched, repeatedly pinnate ; the main stem either simple or forked, with several lateral branches. *Branches* definitely circumscribed, round-topped, bi-tripinnate, the pinnæ a line asunder, patent ; pinnules subulate and erect. *Articulations* visible in all parts of the frond, and uniformly much shorter than their diameter. *Colour* a dark brown. *Substance* rather rigid. This plant, which I first received from Dr. Durkee of Boston, is so unlike many of the preceding varieties, particularly those called *plumosa* and *gracillima*, that few persons, on a mere inspection of a solitary specimen, would suspect them to belong to the same species ; and when first I examined Dr. Durkee's specimen I regarded it as specifically distinct, and hoped it might be allowed to bear his name. A more extended reference to other specimens from various quarters now induces me to consider it a very extreme form, in which the characters of the var. *disticha* are exaggerated.

Plate XVII. C. *Fig. 1.* *POLYSIPHONIA nigrescens, var. Durkeei* ; the natural size. *Fig. 2,* part of a branch and ramulus ; *fig. 3,* cross section of a branch ; both magnified.

25. *POLYSIPHONIA Woodii*; stem robust, flexuous, strongly compressed, distichously branched, decompound-pinnate ; pinnæ (or primary branches) distant, patent, tri-quadri-pinnate, the pinnules pinnato-multifid ; ultimate ramuli subulate, incurved ; internodes in all parts of the frond very much shorter than their diameter, many striate, with pellucid dissepiments, those of the stem with two (!) axes of radiation ; tetraspores in a single row in the ramuli.

HAB. On the Pacific Coast, in lat. 38° 12', Lieut. Wood (1846). Golden Gate, California, *Capt. N. Pike* (1851). (v. s. in Herb. Hook. et T. C. D.)

Frond (in the largest specimen seen by me) about 5 inches long, twice as thick as hog's bristle, compressed, somewhat zigzag, distichously branched ; the branches half an inch asunder, alternate, patent, one to two inches long, nearly equal, decompound pinnate, their primary pinnæ half an inch long, about three or four times pinnately parted, all the laciniae alternate. The ultimate ramuli are subulate, acute, incurved, not a line in length. Every part of the frond is exactly distichous. The internodes are visible throughout with the help of a pocket lens, and are much shorter than their breadth, about ten striæ or tubes being visible on a lateral view in the ramuli, and a greater number on the larger branches. All the interspaces are pellucid ; in the stem only are the internodes partially coated with secondary cellules. A transverse section of the stem is a long ellipse, having two axes (or foci) round which the tubes radiate, a structure which I have never seen in any

other species. *Conceptacles* unknown. *Tetraspores* of large size, forming a single row through the centre of the ultimate ramuli. *Colour* a brownish red. *Substance* soft, but not soon decomposing. In drying, the plant adheres closely to paper.

A very remarkable species, abundantly different from any other North American one known to me. I wish it to bear the name of Lieut. Wood, R. N., who, while cruising in the Pacific Ocean in H. M. S. "Pandora," collected several interesting Algæ, which he communicated to Sir Wm. J. Hooker, in whose Herbarium I have examined them. I have recently received from Mr. N. Pike of Brooklyn a Californian specimen agreeing in all characters with Lieut. Wood's original one.

26 *POLYSIPHONIA dictyurus*, J. Ag.; filaments tufted (1-2 inches high) capillary, rather rigid, sparingly branched; branches virgate, simple, set throughout with short, pinnato-multifid, squarrose, quadrifarious ramuli, which are densely crowded toward the ends of the branches; internodes visible throughout, many-tubed, much shorter than their breadth. *Kütz. Sp. Alg.* p. 838.

HAB. Pochetti, Pacific Coast of the Mexican Republic, *Liebman!* (v. s. in Herb. T. C. D.)

Stem short, with a few lateral branches. *Branches* 1-2 inches long, laxly clothed below, very densely set above with short pinnato-multifid ramuli one or two lines in length; the lowest of which are shortest and subsimply pinnate, the upper longer and more compound, their pinnules once or twice forked or irregularly multifid. *Tubes* about twelve in the stem. *Colour* under the microscope a dull brown. *Substance* rigid. It does not adhere to paper in drying.

27. *POLYSIPHONIA thyrsgera*, J. Ag.; "two inches high, tufted, becoming very black in drying, rigid; branches setaceous, virgate, above densely clothed with curved acute, cymose or racemose, tetraspore-bearing ramuli (*Carpoclonia*, Kütz.); internodes of the branches thrice as short as broad, ten-tubed, of the fruit-bearing ramuli twice as short." *Kütz. Sp. Alg.* p. 838.

HAB. La Guayra, Mexico, *Liebman.*

I have not seen this plant, for which I adopt Kützing's description, slightly altered.

27. *POLYSIPHONIA verticillata*, Harv.; filaments short, creeping, setaceous, sparingly branched; branches erect, densely beset on all sides with simple, incurved, acute ramuli; articulations many-tubed, much shorter than their diameter in the branches, rarely as long as broad in the ramuli; tubes ten or twelve. *Harv. in Bot. Beechey*, p. 165 *Kütz. Sp. Alg.* p. 839.

HAB. California, *Capt. Beechey*. (v. s. frustulum in Herb. T. C. D.)

One to two inches high, with the aspect of a *Cladostephus*, or perhaps more nearly resembling *Rhodomela larix* in miniature. The ramuli, though very densely set on all sides, imbricate, and crowded round the ends of the branches, are scattered, not whorled. The articulations are on a close examination clearly visible in the branches as well as the ramuli, but, owing to the opacity of the substance, only after long steeping the dry plant. The internodes are uniformly very short, the tubes broad.

I regret that I can throw little additional light on this imperfectly known plant, of which I possess merely one or two minute fragments. These are different from any North American specimens I have seen, but seem nearly allied to *P. dictyurus*. The specific name *verticillata* conveys an incorrect idea.

28. POLYSIPHONIA *fastigiata*, Grev.; tufts globular, fastigate; filaments rigid, setaceous, of nearly equal diameter throughout, many times dichotomous; axils patent; internodes shorter than their diameter, many-tubed, with a dark central spot; tubes sixteen to eighteen. *Ag. Sp. Alg. Vol. 2, p. 67. Kütz. Sp. Alg. p. 809. Harv. Phyc. Brit. t. 299. Conferva polymorpha, Linn. Dillw. Conf. t. 44. E. Bot. t. 1764.*

HAB. Parasitical on *Fucus nodosus* and *F. vesiculosus*. Common on the East Coast from Halifax to New York. Golden Gate, California, *Capt. Pike*, (v. v.)

Tufts globose, one or two inches in diameter, dense. *Filaments* rigid, dark-brown, excessively branched from the base, the main branches and their primary divisions dichotomous, with wide axils, the ramuli less regular in ramification, and often alternately multifid. All the apices are of nearly the same length, giving the tuft an appearance of having been clipped all round like a thorn bush. The internodes frequently show, besides their longitudinal bands, a dark central spot, which is the coloured bag of the axial cell seen through the outer walls. *Conceptacles* ovate, somewhat acuminate, sessile near the ends of the branches, often two or more close together.

This species, though named *polymorpha* by the earlier writers on Algæ, is very constant to its characters, and if once seen, can hardly be mistaken for any other. It is very constantly found on *Fucus nodosus*, wherever that common littoral plant grows; and more rarely on *F. vesiculosus*. *Capt. Pike's* specimens from the Pacific coast are identical with Atlantic-grown individuals.

IX. BOSTRYCHIA, *Mont.*

Fronde dull purple, filiform, branched, inarticulate (or sub-articulate with very

short internodes), tessellated with quadrate cells; axis tubular, articulated, surrounded by one or more concentric series of oblong coloured cells, which are successively shorter toward the circumference; surface cells quadrate. Ultimate *ramuli* frequently monosiphonous. *Conceptacles* ovate, terminal, containing a tuft of pear-shaped spores. *Tetraspores* contained in fusiform, terminal stichidia, in a double row.

A very natural and now pretty extensive genus, consisting of small Algæ of similarly amphibious habits, and all of a dull, blackish or livid purple colour. It is difficult to distinguish some of them by a definite character from *Dasya*, and others from *Polysiphonia*; others again have been placed in *Rhodomela*. They rarely grow in the open sea. Their favourite localities are near high water mark, often in places where they are seldom submerged, or in brackish water, as the estuaries of rivers; and some grow even in perfectly fresh water, in mountain streams far removed from the sea. The same species, as in the case of *B. vaga* of Kerguelen's Land, may occasionally be traced from the rocks and stones about high water mark, to a considerable distance inland.

The typical species are inarticulate, but are beautifully dotted with large square cells arranged in transverse lines, several cells in each band. Such transverse bands are evidently of the same nature as the many-tubed internodes or articulations of *Polysiphonia*, the difference being one of degree, and not of kind, and consisting in the very short and minute cells of the *Bostrychia* compared to the elongated tubular cells of the *Polysiphonia*. In other species, as our *B. rivularis*, the cells of the stem are longer, and the *ramuli* are almost articulated, the lower parts pluri-striate, their ends unipunctate or monosiphonous. Yet this species cannot be naturally separated from *B. radicans*, *B. Hookeri*, &c. which are of the typical structure; nor yet again, as I think, from *B. Toumeyii*, which, were there no such connecting links, would probably be placed in *Dasya*. Again, *B. calamistrata* is in all respects, except in the structure of its *ramuli*, an orthodox species of *Bostrychia*; but by these single-celled *ramuli* it is associated with the aberrant *B. Toumeyii*.

SUB-GENUS 1. EUBOSTRYCHIA. Peripheric cells in several concentric rows (as seen in a cross section of the stem).

1. BOSTRYCHIA *Montagnei*; frond ultrasetaceous, opaque; main stems three or four times pinnated, strongly reflexed or arching backwards; pinnæ distichous, close together, horizontally patent, recurved, the terminal ones often secund; pinnules capillary, pinnulate or bipinnulate, dotted, inarticulate, their tips alone unipunctate, surface cells quadrate; apices inflexed; stichidia elongate, acuminate. (TAB. XIV. B.)

HAB. On the mangrove stems, at high water mark. Key West, W. H. H. Bahia Honda, Prof. Tuomey (9). (v. v.)

Fronds in large, bushy tufts, three to four inches long. *Stems* thicker than hog's bristle, gradually attenuated upwards, undivided, strongly arched or deflected backwards; in the lower half, generally thorny with the remains of broken branches set one to two lines apart; in the upper half, closely set with distichous, alternate, nearly horizontal branches. *Branches* bi-tripinnate, the lowermost shorter and less compound, the middle ones longest, the upper short and usually bent in pairs to one side, and thus (falsely) secund. *Stems* and *ramuli* opaque, inarticulate; the stems dotted with many rows of small, quadrate, pellucid-bordered cells, the ramuli dotted with similar but fewer cells, and the extreme tips consisting of a single row of cells. A cross section of the stem shows a minute central cavity surrounded by many rows of small cells, each containing a small purple endochrome. I have not seen conceptacles. *Stichidia* are common, and are formed in the ramuli; they are linear-lanceolate and acuminate and contain a double row of tetraspores. *Colour* a brownish purple, varying in intensity. *Substance* rigid. The plant does not adhere to paper in drying.

This forms large tufts on the stems of mangrove trees at various places near Key West, and probably occurs in similar situations among the other reefs and keys. It invests the stems up to the very limit of high water mark, and is consequently left dry for many hours each tide; and then strongly resembles collapsed fronds of *Hymenophyllum Tunbridgense*.

The specific name is imposed in honour of Dr. Camille Montagne of Paris, the well known author of many works on Cryptogamia, and who first defined this genus. *B. Montagnei* is one of the largest and handsomest species with which I am acquainted, and I have much pleasure in dedicating it to my learned friend.

Specimens of a strangely metamorphosed variety of this plant, said to have been collected at Valparaiso, have been communicated to me by Mrs. Tyers of Bristol (England). In this variety or monstrosity, several of the secondary branches (or primary pinnæ) are resolved into a system of capillary, subdichotomous, excessively divided branches, two to three inches long. This completely alters the aspect of the plant, and these feathery specimens might pass for a different species, were it not that, on the same stem, some branches retain their proper character.

Plate XIV. B. *Fig. 1.* *BOSTRYCHIA Montagnei*, the natural size. *Fig. 2.* portion of a branch, with pinnæ; *fig. 3.* a pinnule and a stichidium, on opposite sides of the branchlet; *fig. 4.* transverse section of the stem; more or less highly magnified.

2. *BOSTRYCHIA calamistrata*, Mont.; stem subcompressed, inarticulate, dotted, alternately branched; branches distichous, subhorizontally patent, oblong, circumscribed, bi-tripinnate; pinnæ closely set, dotted; pinnulæ capillary, multifid, involute, articulate, single-tubed; articulations rather longer than broad; conceptacles ovate, terminating the dotted pinnæ; stichidia similarly placed (on different individuals) spindle shaped, incurved. *Mont. Nat. Hist. Cuba*, p. 36, t. 4, fig. 1. *Harv. Ner. Austr.* p. 68. (var. *repens*). (TAB. XIV. C.)

HAB. On mangrove stems, and on logs about the wharf, at Key West, *W. H. H.* (No. 7). Pine Island, *Prof. Tuomey* (10^b.) (v. v.)

Stems 1-2 inches high, as thick as hog's bristle, alternately branched; branches an inch long, horizontally patent, simple or once or twice divided, distichous, closely bi-tri-pinnate. The lower parts of the stem are generally beset with short, spine-like, broken branches, the remains of earlier growth; the upper parts, as well as the main branches and their divisions, closely beset with very slender, alternate, patent, simple or multifid, inflexed or involute, capillary ramuli. The stems and branches and the primary pinnæ are solid, inarticulate, and dotted with quadrate cells; the pinnulæ and their divisions articulate, formed of a single series of oblong cells, once and half or twice as long as broad. A cross section of the stem shows a small central cavity surrounded by numerous rows of coloured cells. *Conceptacles* ovate, terminating the primary pinnæ, containing a tuft of pear-shaped spores. *Stichidia* spindle shaped, terminal, curved, acuminate. *Colour* a brownish purple. *Substance* cartilaginous, rigid. It does not adhere to paper.

Our specimens agree with those received by Dr. Montagne from Cuba. They differ from the plant described in *Harv. Ner. Austr.* as above quoted, in being erect, and destitute of root-like discs.

Plate XIV. C. *Fig. 1.* *BOSTRYCHIA calamistrata*, the natural size. *Fig. 2*, apex of a branch, with conceptacles; *fig. 3*, a conceptacle and ramulus; *fig. 4*, spores; *fig. 5*, small portions of the ramulus; *fig. 6*, cross section of the stem; *fig. 7*, a stichidium; all more or less highly magnified.

SUB-GENUS 2. STICTOSIPHONIA. Peripheric cells in a single row.

3. *BOSTRYCHIA rivularis*; stems an inch high, rising from creeping filaments, capillary, bipinnate; pinnæ distichous, alternate, patent, inarticulate, tessellated with subquadrate cells; pinnulæ subdistant, simple or forked, attenuate, marked with about two rows of oblong cells; peripheric cells seven or eight; conceptacles ovate, terminating the lowest pinnæ, which are then abbreviated and bare of pinnules. (TAB. XIV. D.)

HAB. Isle of Shoals, *Mr. Pike*. Hellgate, New York, *Mr. Hooper*. " On *Spartina glabra*, and on the Palmetto logs in the Ashley and Cooper Rivers, Charleston, *Prof. Bailey* and *W. H. H.*, also found by *Prof. Bailey* in the St. John's River, Florida. (v. v.)

Fronde an inch high or less, slender, spreading over the logs in wide patches, rising from a mat of creeping fibres, attached here and there by discs. *Stems* somewhat flexuous, erect, pinnate or bipinnate, or in luxuriant specimens sub-tripinnate. *Pinnæ* alternate, distant, spreading, laxly pinnulate. *Pinnulæ* also patent, subulate, sometimes again compounded. The whole frond is tessellated with quadrate or oblong cells arranged in longitudinal rows, the ramuli having about two rows, the larger

divisions three or four. A cross section of the stem shows seven or eight cells surrounding a central cavity. *Conceptacles* borne on the ends of shortened branches. I have not seen stichidia. *Colour* a dull brownish purple. *Substance* rigid. It does not adhere to paper in drying.

This plant is abundant in estuaries of rivers in Carolina and Florida, and probably in other Southern States. The only other specimens I have seen were given me by Capt. Pike of Brooklyn, having been collected by him in July, 1848, at the Isle of Shoals (lat. 43°); and by Mr. Hooper, collected at the estuary of the Hudson. I have not heard under what circumstances Capt. Pike's plant grew, whether in open sea or estuary. There is no appreciable difference in ramification between it and the Carolinian specimens.

Plate XIV. D. *Fig. 1.* *BOSTRYCHIA rivularis*, growing on a piece of wood; the natural size. *Fig. 2.*, two erect stems, rising from a creeping filament; *fig. 3.*, pinna and portion of a stem; *fig. 4.*, cross section of the stem; *fig. 5.*, conceptacle; all magnified.

4. *BOSTRYCHIA Tuomeyi*; frond capillary (small), irregularly divided; branches erecto-patent, not much branched, articulato-tessellate, four-tubed and subquadrangular, rough with broken ramuli below, densely clothed with very slender, inflexed, alternately branched, single tubed ramuli above; cells of the ramuli once and half to twice as long as broad. (TAB. XIV. E.)

HAB. On rocks. Pine Islands, Florida, *Prof. Tuomey*. (10). (v. s. in Herb. T. C. D.)

Fronds tufted, about inch and half high, capillary, irregularly divided into numerous, erecto-patent, simple or forked branches. Lower part of the stem and branches naked, or beset with the spine-like remains of broken ramuli; the upper and younger parts densely clothed with inflexed, very slender, slightly branched ramuli. The stem and branches are tetrasiphonous, four large coloured cells surrounding a central cell; and when viewed laterally appear articulate, the internodes shorter than their breadth and marked with three tubes. The *ramuli* are formed of a single string of cells. *Colour* a dark lurid purple. *Substance* rather soft. In drying, it adheres pretty firmly to paper.

I have seen no fructification, and the generic relations are therefore at present doubtful, the structure of the frond being that of a *Polysiphonia* with very short internodes. Still it seems to me to range naturally in the present group, from the other species of which it chiefly differs in having very few (four) cells in the peripheric stratum. The ramuli are of precisely the same structure as those of *B. calamistrata*, and the colour is that blackish purple so characteristic of this genus.

I bestow the specific name in compliment to Prof. Tuomey, of the University of Alabama, to whom I am indebted for an interesting collection of Floridan Algæ.

TAB. XIV. E. *Fig. 1.*, *BOSTRYCHIA Tuomeyi*; the natural size. *Fig. 2.*, apex of a branch; *fig. 3.*, small portion of a branch, to show the cellular structure; *fig. 4.*, cross section of the same; *fig. 5.*, a ramellus; *fig. 6.*, small portion of the same; all more or less highly magnified.

X. DASYA. *Ag.*

Frond filiform or compressed, branching, opaque or rarely articulated, having a polysiphonous, articulate axis, coated externally with accessory cells. *Branches* beset with, or resolved at their ends into slender, single-tubed, confervoid, articulate ramelli. *Conceptacles* ovate, acuminate, sessile or pedicellate, affixed to the compound branches, and containing a tuft of pear-shaped spores. *Tetraspores* in lanceolate stichidia (or transversely banded, pod-like receptacles) formed on the confervoid ramelli.

A large and considerably diversified genus, occurring in both hemispheres. As here understood, it is chiefly characterised by the confervoid, jointed ramelli, issuing from a compound, polysiphonous, but mostly opaque and outwardly inarticulate frond; and the lanceolate, pod-like receptacles of tetraspores, borne by the confervoid ramelli, out of whose branches they are formed. The ramelli are of the same structure as the articulated fibres which clothe the ends of the young branches in *Polysiphonia*, *Rhodomela*, etc. but in those genera they are mostly colourless, very fugacious, and have no connection with the tetrasporic fructification; in *Dasya*, on the contrary, they are persistent, containing coloured cells, and finally originating the tetrasporic fructification. In the former cases they accompany the early development of the branches only, in the latter they are characteristic of the species at all ages. In *Bostrychia* the stichidia are borne by the compound branches, and in *Polysiphonia* the tetraspores are dispersed through slightly modified and distorted polysiphonous ramuli.

In the *Nereis Australis* (p. 58) I have grouped the species under five subgenera, four of which are represented on the North American coasts: viz.

SUBGENUS 1. *COMPSOTEIA.—*Frond* more or less distinctly articulated, especially in the upper branches, decompound-pinnate, distichous; the lesser branches dichotomous, resolved at the apices into dichotomo-multifid, confervoid ramelli.

1. DASYA (COMPOSTEIA) *Gibbesii*; stem compressed, areolate, inarticulate, with a central line of short, transverse striæ (nodes of the axial tube), distichously branched, decompound-pinnate; branches bi-tripinnate, with an obovate outline; pinnules subarticulate, dichotomous, their terminal divisions resolved into dichotomous, single-tubed, fastigate, confervoid ramelli; articulations of the ramelli twice

* This subgenus (misspelled *Campsotela*) is strangely misunderstood by Kützing in his "Species Algarum," p. 797—only two out of the fifteen species which he enumerates agreeing with the character. His first species is a *Callüthamnion*; his 3rd, 5th, 10th, are *Rhodonemata*; his 9th a *Wrangelia*; his 11th, a *Stichocarpus*; 12th, a *Lophothalia*; and 14th and 15th, *Bostrychieæ*. The name given to this uncombed assemblage is *Eupogonium*.

as long as broad ; apices bluntish ; stichidia lanceolate-acuminate, on the lower forks of the ramelli. *Polysiphonia Gibbesii*, Harv. MSS. in Herb. Gibbes. (TAB. XV. A.)

HAB. At Key West, abundant. Dr. Wurdeman, Prof. Tuomey (27), W. H. H. (8), &c. (v. v.)

Root a small disc. Fronds tufted, 4-8 inches high, half a line to nearly a line in diameter in the middle, and tapering to the base and apex, distichously much branched. Stem undivided, slightly zigzag, naked for an inch or more above the base, thence upwards furnished at intervals of about half an inch with several alternate branches, much narrower than the part from whence they spring, the lower ones long, and again compounded, the upper gradually shorter. Branches in circumscription obovate, fastigate, round-topped, twice or thrice pinnated ; the pinnules dichotomous, with rounded angles, their ultimate divisions resolved into single-tubed, many times dichotomous ramelli. The stem and branches are compressed, coated with polygonal cells, inarticulate, with a medial row of minute dark coloured, transverse lines, a quarter of a line apart and visible to the naked eye, or with a pocket lens. These lines are the nodes of the central tube of the axis of the frond. The pinnules are cylindrical and articulate, polysiphonous and somewhat veiny in their lower parts, few-tubed in the upper, and at length passing into the single-tubed ramelli. The stichidia are numerous on the lower forks of the ramelli ; several on the same ramellus ; they are pedicellate, oblongo-lanceolate, acuminate, and contain a triple series of large tetraspores. Conceptacles unknown. Colour a purplish lake, growing darker and browner in drying. Substance of the stem and branches cartilaginous, of the ramelli soft and tender. In drying, the plant adheres pretty firmly to paper.

A beautiful species, unlike any other North American one, but allied to *D. Gunniana* and *D. Lawrenceana* of Tasmania, from both which, however, it is abundantly distinct. The name is given in honour of Prof. Lewis R. Gibbes of Charleston, from whom I received the first specimen of this and several other interesting Alga of Florida.

Plate XV. A. Fig. 1. *DASYA Gibbesii* ; the natural size. Fig. 2, apex of a lesser branch with terminal ramelli and stichidia ; fig. 3, a stichidium ; fig. 4, a tetraspore ; fig. 5, portion of a ramellus ; fig. 6, part of the stem, to show surface cellules, and medial, dark striæ ; fig. 7, longitudinal section of the same through the smaller diameter ; fig. 8, transverse section ; all more or less magnified.

SUBGENUS 2. RHODONEMA. Frond inarticulate or rarely articulate, cylindrical, irregularly branched ; branches more or less completely clothed on all sides with dichotomous, single-tubed, confervoid ramelli. Stichidia glabrous.

2. *DASYA* (RHODONEMA) *elegans*, Ag. ; frond very soft and flaccid, soon decomposing ; stem robust, inarticulate, elongate, alternately decompound ; branches filiform, of unequal length, undivided, all the younger parts clothed with byssoid,

purple-lake, dichotomous ramelli ; articulations of the ramelli many times longer than broad ; conceptacles urnshaped, on long pedicels, rising from the branches ; stichidia linear-lanceolate. *Ag. Sp. Alg.* 2, p. 117. *Kütz. Sp. Alg.* p. 796. *Rhodonema elegans*, Mert.

HAB. Growing on other Algæ, on woodwork, rocks, &c. from low water mark to the depth of several fathoms. Annual. Nantucket, *Dr. Durkee*. Greenport. Providence, *Prof. Bailey and Mr. Olney*. Very common in New York Harbour from Hellgate to Red Hook, *Messrs. Bailey, Hooper, Walters, Pike, Congdon, Calverley, &c.* Charleston, *Prof. Gibbes, W. H. H.* Key West, *Prof. Tuomey, Dr. Blodgett, W. H. H.* (v. v.)

Root discoid. *Stems* from six inches to one, two, or three feet long, varying in diameter from the thickness of hog's bristle to that of a crowquill, or in the larger specimens from one to two lines in diameter, softly cartilaginous when quite fresh, but soon becoming very flaccid, either quite simple or divided below into a few secondary stems, and set throughout the whole length with numerous lateral branches, spreading on all sides. The branches are very irregularly placed, sometimes widely scattered, sometimes densely crowded ; alternate or subopposite, or even fascicled ; they are simple, patent, virgate, either destitute of lesser branches, or furnished with very numerous, short lateral branches, so that the general frond is sometimes but slightly divided and sometimes very bushy. All the larger and smaller branches and the main stem when young are densely clothed with exceedingly slender, bright purple, soft, confervoid ramelli. These *ramelli* are from two to four lines long, dichotomous, a few times distantly forked, with the terminal laciniae very long and filiform, but not tapering to the apex ; the apical cell being very blunt. The articulations of these ramelli are of great length. *Conceptacles* abundantly scattered along the branches, on long stalks. *Stichidia* attached to the ramelli, one or more on each ramellus near its base, very slender, lanceolate, acuminate, containing a double or triple row of tetraspores. *Colour* in all parts a brilliant purple lake, well preserved in drying. *Substance* soon decomposing in fresh water. In drying, the plant adheres most closely to paper.

There are two principal forms ; one, which grows in deep water, has very long simple branches, destitute of laterals ; the other, which grows within tide marks, is short and bushy, with abundant secondary branches. The European forms of this plant do not essentially differ.

3. *DASYA* (RHODONEMA) *ramosissima* ; stem cartilaginous, tough, inarticulate, robust, attenuated and flaccid upwards, much branched ; branches several times alternately decompound, denudate ; ultimate divisions setaceous, subarticulate, more or less completely clothed with dichotomous ramelli ; their apices incurved, attenuate ; articulations three to five times as long as broad. Var. *a* ; frond naked, except the tips of the ultimate branches, which are crowned with a dense tuft of

ramelli. Var. β . more densely branched and bushy, with shorter branches, and more diffused, more copious, and much attenuated ramelli.

HAB. At Key West, *W. H. H.* (9, 10). (v. v.)

Frond six to twelve inches long or more, as thick as sparrow's quill below, much attenuated upwards, divided near the base into several principal branches or stems, which are excessively decompound and bushy ; each set of lesser branches springing along the sides of the primary branches irregularly. The ultimate branches are from half an inch to an inch long, not so thick as hog's bristle, imperfectly jointed, the internodes areolated with irregularly formed cells, and about as long as broad ; they are sometimes naked except at the extremity, but are more usually clothed beyond the middle with densely crowded ramelli. These ramelli are from a quarter line to a line in length, of much greater diameter than those of *D. elegans*, erectopatient, dichotomous, their divisions generally arched inwards and tapering to a point. The axils are all narrow. The articulations very variable in different individuals, sometimes only about as long as broad, sometimes 3-5 times as long. A cross section of a small branch shows five primary tubes, surrounded by numerous external cells, smaller to the circumference : in the larger branches and stem the external border of cells is proportionably thicker and denser. I have only seen immature *stichidia* ; they are linear oblong, and subacute, on the first or second forks of the ramelli. *Colour* a brownish red or purplish brown, becoming much darker in drying. *Substance* tough and tenacious, but very soft. This plant bears immersion in fresh water for some time without injury, and in drying adheres strongly to paper.

4. *DASYA* (*RHODONEMA*) *mollis* ; robust, very soft and flaccid, alternately much branched, bushy ; branches inarticulate, twice or thrice compounded, their ultimate divisions short ; all the younger parts clothed with confervoid ramelli which are laxly scattered on the larger and densely imbricated on the smaller branches ; ramelli patent, dichotomous, from a robust base much attenuated, and very slender ; axils wide ; lower articulations short and cellular, upper four to six times as long as broad, single tubed ; *stichidia* oblong-acuminate.

HAB. Key West, rare. *W. H. H.* (14). (v. v.)

Frond 2-3 inches high, as thick as sparrow's quill, irregularly much branched, bushy, often wider in the spread of the branches than the height of the stem. The stem in my specimens divides a short distance above the base into three or four main divisions, which spread subhorizontally, fork irregularly, and are decompoundly once or twice divided : the branches alternate, or irregular, of unequal length, long and short indiscriminately mixed. All the branches and their divisions are hirsute with squarrose, patent ramelli, laxly scattered over the older

parts, crowded on the younger, and very dense toward the extremities. These ramelli are about a quarter of a line long, their lower forkings much thicker than the upper, which are rather suddenly attenuated and very slender, the terminal divisions much prolonged. The lower articulations of the ramelli are about as long as broad, sub-opaque and multicellular; the upper cylindrical, 4-6 times as long as broad. A cross section of the stem shows five large primary tubes and five alternate secondaries, surrounded by small cells. *Stichidia* near the base of the ramelli, one on each, subsessile, oblong-acuminate, very acute, containing a triple row of tetraspores. *Substance* exceedingly soft and tender. *Colour* pale red, rosy toward the tips. It closely adheres to paper.

A smaller plant than *D. ramosissima*, with more slender ramelli. The external habit and the substance are more those of a *Dudresnaia* than of a *Dasya*.

5. *DASYA* (RHODONEMA) *mucronata*; robust, elongate, cartilaginous, inarticulate, decompound; branches several times alternately divided, denudate, their extremities and the smaller branches densely clothed with squarrose, rigid, confervoid ramelli; ramelli robust, patent, dichotomous, their axils wide and divisions divaricating, their apices remarkably mucronate; articulations twice as long as broad, dissepiments slightly contracted.

HAB. Abundant at Key West, W. H. H. (11). (v. v.)

Root a spreading disc, sometimes half an inch in diameter. *Stems* one or more from the same base, six to eight inches long or more, as thick as crowquill below, attenuated upwards, simple or once or twice divided, bare of branches for an inch or two above the base; thence upwards furnished with numerous scattered or crowded, alternate or irregular lateral branches. These branches are about as thick as hog's bristle, 4-5 inches long, the lowest longest, and are furnished with one, two, three, or more series of similar lateral branches, all of which spread at wide angles; the penultimate ones short. The larger branches are generally denuded in full grown plants, but all the younger portions are clothed on all sides with ramelli, which are particularly dense toward the extremities. These *ramelli* are scarcely half a line long, rather rigid, standing on the branches at right angles, and are many times regularly dichotomous, with divaricating branches. The terminal cell of each segment of the ramellus is very small, subulate and acute, forming a mere *mucro* to the large oblong cell immediately below it. The articulations are uniformly about twice as long as broad. A transverse section of a branch shows five large primary tubes, surrounded by a wide band of small cells. The colour of the stem and branches is a dull brownish red, of the ramelli brighter and more rosy. The *substance* is firmer and more rigid than in most others of this genus. In drying, it does not adhere strongly to paper.

This species is frequently infested by parasites. It is one of the largest and coarsest of the subgenus, and readily known, on microscopic examination, by the mucronate ramelli.

6. *DASYA* (RHODONEMA) *Wurdemanni*, Bail. ; capillary, of small size, (an inch high), once or twice forked ; secondary branches alternate or secund, arched, articulate, hirsute with squarrose ramelli ; ramelli very patent, many times dichotomous, sub-rigid, their divisions divaricating, apices acute, articulations once or twice as long as broad. (TAB. XV. C.) var. β . *dichotoma* ; more regularly dichotomous, with shorter and straighter secondary branches.

HAB. Abundant on Algæ and corals, at Key West. *Dr. Wurdeman, W. H. H.* (15). (v. v.)

This forms small, roundish, dense, fastigate tufts, or often is entangled among the branches of the Algæ which it infests.

The *stems* are an inch or two high, about as thick as coarse human hair, once or twice forked, and then alternately or secundly branched. The secondary branches are very frequently secund, erect, arching inwards, with the ends inrolled, and are beset throughout with ramelli which are short and subdistant below, gradually longer and more densely set above, and also longer and more numerous on the outer than on the inner side of the curved branch. These ramelli stand almost at right angles on the branch, are several times forked, with very wide axils and divaricated segments, and their articulations are seldom more than twice as long as broad. The stem and branches are obviously jointed, the internodes few-tubed with pellucid nodes, but I have not been able to determine the number of tubes, whether four or five, owing to the very imperfect absorbent powers of the dried cells. The *colour* is a dull red, inclining to brown. The *substance* is somewhat rigid, not at all lubricous. In drying, the plant adheres pretty firmly to paper.

β . is a little different in aspect, the stem being more regularly dichotomous, the secondary branches shorter and straighter, and the ramelli more equally distributed. It somewhat resembles some weak-growing forms of *D. arbuscula*, to which *D. Wurdemanni* is certainly allied, although perfectly distinct.

The specific name was bestowed by Prof. Bailey in honour of the late Dr. Wurdeman, who first detected this curious little species, and to whom we are indebted for an interesting series of Key West Algæ.

PLATE XV. C. *Fig. 1*, *DASYA Wurdemanni*; the *natural* size. *Fig. 2*, some branches; *fig. 3*, portion of a branch, with ramellus; the latter figures *magnified*.

SUBGENUS 3. LOPHOTHALIA. *Fronde* articulate or opaque, four-tubed, virgate, alternately branched ; branches naked or clothed with simple or pinnated, single tubed, confervoid ramelli. *Stichidia* rising from the branches, hirsute with ramelli.

7. *DASYA* (LOPHOTHALIA) *Tumanowiczii*, Gatty ; stem cartilaginous, opaque, robust, attenuated upwards, alternately decompound ; branches elongate, setaceous, their divisions capillary, set with short spine-like branchlets, and imperfectly articulated ; internodes once and half as long as broad, coated with polygonal cells ;

branchlets articulate; ramelli few, near the ends of the branches, sub-simple or pinnate; stichidia lanceolate, clothed with ramelli (formed in the rachis of a pinnated ramellus). *D. chordalis*, Harv. in *Herb.*

HAB. Key West, W. H. H. (12), Dr. Blodgett (59 and 75). West Indies, Mr. Tumanowicz. (v. v.)

Root scutate, with lateral, branching fibres. *Stem* 6—12 inches long or more, as thick as sparrow's quill at base, tapering upwards and capillary above, cartilaginous and tough below, very flaccid above, much branched; dividing near the base into several principal branches or secondary stems, which are repeatedly compound in an irregularly pinnate manner. The primary division sometimes, from repeated suppression of parts, appears dichotomous; sometimes several of the secondary branches are secund, and in other specimens crowded together and almost tufted. The secondary branches are about as thick as hog's bristle, several inches long, simple or having a second or third series of similar thread-like branches, beset at short intervals with minute, spine-like, subulate ramuli. These latter are readily seen with the help of a pocket lens, but not very obvious without one, and are articulate, each consisting of four or six four-tubed internodes of equal length and breadth. The main stem and larger branches are opaque, coated with irregular cells; the younger branches imperfectly jointed, the internodes areolated with irregular polygonal cells, and about once and half as long as broad. A transverse section of a small branch shows four primary and four alternate secondary tubes, and about eight small superficial cells; a section of the stem still exhibits the four primary tubes, but the external coat is very wide and dense. Single tubed *ramelli* are irregularly scattered on the younger parts of the branches, as well as on the spine-like ramuli, from whose axils they often issue; they are slender, pinnate, sometimes bi-tri-pinnate, the pinnæ very erect; and the articulations 3-4 times as long as broad. *Stichidia* are formed from the swelling of the upper portion of the rachis (or jugament) of these ramelli, and are densely clothed with the pinnules; they are moniliform, and contain a string of tetraspores. When the transformation is incomplete, the stichidium appears as if borne on the end of the rachis, but sometimes almost the whole ramellus is converted into fructification. *Colour* a fine clear red. *Substance* tough but soft. In drying, the plant adheres closely to paper.

I have received a West Indian specimen of this plant from Mrs. Gatty, at whose request I give it the name of the gentleman from whom she received it, Mr. Tumanowicz, a Pole now resident in England, and a most ardent student of marine botany. I believe I have already distributed some specimens under the MSS. name *chordalis*, which I now lay aside.

8. *DASYA* (LOPHOTHALIA ?) *lophoclados*, Mont. ; stem setaceous, irregularly dichotomous, sub-articulate; branches divaricating, decompound, their ultimate divisions articulate; all the younger parts of the frond densely clothed with sparingly

branched, alternately divided, straight, hairlike ramelli; internodes of the stem about once and half as long as broad, of the ramelli many times longer than their diameter; fruit unknown. *Mont. An. Sc. Nat.* 1842, p. 254. *Polysiphonia lophoclados*, Kütz. *Sp. Alg.* p. 834.

HAB. Floating in the sea near Key West, *Prof. M. Tuomey* (No. 6). (v. s. in Herb. T. C. D.)

Stems 3-4 inches long or more, as thick as hog's bristle, attenuated upwards, several times irregularly forked, the divisions widely spreading with very obtuse angles, the lesser branches more and more irregularly forked, the ultimate ones alternately divided. The lower parts of the stem are subopaque; the larger branches generally exhibit more or less definite veiny internodes, and the smaller branches are clearly articulate, their internodes once and half as long as broad, thinly coated with minute cells. A cross section of a branch shows four large primary tubes, four secondaries and several external cells. The ramelli are very slender, about a line long, or a little longer, straight, erectopatent, spreading on all sides and abundantly clothing the lesser divisions of the frond; they are less frequent on the larger branches, and altogether wanting in the lower parts. They are not much branched, between alternately pinnate and dichotomous, their branches simple, very long and straight. The articulations toward the base of the ramellus are twice or thrice as long as broad, in the middle part 8-10 times their diameter. The colour of the stem is brownish, that of the ramelli a purple lake, browner in drying and greenish in decay. The substance is soft and delicate. In drying, it adheres closely to paper.

I have compared my specimen with a fragment of Dr. Montagne's Haytian one, and they seem of the same species. The fruit is not known, but the habit is that of *Lophothalia*, and should this subgenus ever rank as a genus, this species ought to be called *L. Montagnei*.

SUBGENUS 4. STICHOCARPUS. *Frond* more or less obviously articulate, many-tubed, crimson-lake, decompound-pinnate, distichous, the ultimate pinnules (ramelli) single-tubed, simple, subulate.

9. DASYA (STICHOCARPUS) *plumosa*, Bail. and Harv.; frond inarticulate, compressed, two-edged, distichously bi-tripinnate; the pinnæ elongate, pinnules short, both alternate and densely beset with distichous, often opposite, straight, simple or forked, single-tubed ramelli; articulations of the ramelli thrice as long as broad. *Bail. and Harv. in Bot. Expl. Exped.*

HAB. Puget's Sound, *Capt. Wilkes*. (v. s. in Herb. Sm. Inst.)

A single imperfect specimen of this plant is all that I have seen. The fruit is unknown; the habit is that of a *Ptilota*, but a cross section of the stem shows the

structure peculiar to *Dasya*. The frond is probably several inches long, with an ovate outline, twice or thrice pinnate; the pinnæ elongate, and pinnules short. Both pinnæ and pinnules are closely bordered with distichous, opposite, articulate, confervoid ramelli. Colour a clear carmine.

ORDER II.—LAURENCIACEÆ.

Harv. Man. Br. Alg. Ed. 2, p. 95. Laurenciæ, Hook. fil. and Harv. Lond. Journ. vol. IV. p. 539. Chondriæ in part J. Ag. Alg. Medit. p. 67. Harv. Ner. Austr. p. 75. J. Ag. Sp. Alg. vol. 2, Syn. p. x. Lomentariæ, Endl. 3d Suppl. p. 42. Mont. Pol. Sud. Crypt. p. 122. Part of Chondriæ, Chondrosiphæ and Champiæ, Kütz. Phyc. Gen. pp. 435, 438, 439. Part of Chondriæ, Champiæ and Polysiphoniæ, Kütz. Sp. Alg. pp. 849, 861, 842. Lomentariæ (partly), Lindl. Veg. Kingd. p. 25.

DIAGNOSIS. Rose-red or purple seaweeds with a terete or compressed, rarely flattened, inarticulate or constricted and chambered branching frond composed of polygonal cellules. *Sporiferous-nucleus* contained in external, ovate or globose conceptacles; *spores* pearshaped or obconical, subsessile or formed in the terminal cells of unbranched or paniculate, tufted spore-threads. *Tetraspores* immersed in the branches and ramuli of the frond, scattered without order among the surface cells.

NATURAL CHARACTER. *Root* either a simple disc, or a mat of branching fibres. *Frond* mostly terete, rarely compressed, more rarely flattened, mostly destitute of midrib, preserving nearly the same breadth throughout, decompoundly branched; the branches generally repeatedly pinnated, opposite or alternate, rarely whorled or tufted; sometimes, but very rarely, dichotomous. In the first suborder the frond is solid, inarticulate and opaque, of a firmly cartilaginous substance, wholly composed of polygonal cells packed together round a central cell into a honey-combed structure, the innermost cells being largest, those towards the surface gradually smaller, and the superficial very minute. Sometimes the axial cells form an articulated single-tubed axis; and sometimes several longitudinal filaments run through the centre of the stem, like an immersed rib. In the second suborder the branches at least are hollow, constricted at intervals, and furnished at the constrictions with transverse diaphragms which divide the cavity into separate chambers, filled with a watery mucus, through which a few confervoid filaments, connecting the diaphragms are dispersed.

The *conceptacles* are of two forms, either globose and destitute of pore, bursting open at maturity; or ovate, furnished with a terminal pore through which the ripe spores are discharged. These conceptacles are either formed in the hollowed apex

of abbreviated branches or ramuli, or they are sessile on the sides of the branches. Their *sporiferous nucleus* exhibits considerable modification in the different genera. In the *Bonnemaisoniæ* the spores are properly pear-shaped, rounded at the apex, and tapering at the base into a very slender spore-thread or funiculus of which the spore is the enlarged and fertile terminal cell. These spore-threads are always unbranched; in some species very short, in others long, and either rising in a tuft, from the base of the cavity, or from a cellular basal placenta, which occasionally fills up a considerable part of the cavity and is divided into several lobes. In the *Lomentariæ* the spores are more properly obconical than pear-shaped, truncate at the apex and tapering but slightly at the base. In *Lomentaria* (*Chylocladia* of British writers, not of Agardh) where they taper most to the base, they are nearly sessile, radiating from a central point and closely packed together into a spherical nucleus. In *Champia* they are sometimes shortly obconical, and sometimes ellipsoidal or oblong, and are borne on a much-branched, confervoid placenta, each spore being formed in the terminal cell of one of the branches. Yet these two genera are so similar in aspect and in the structure of the frond that many species of the latter have by most authors been referred to the former.

The *tetraspores* (known only in *Laurencia*, *Lomentaria* and *Champia*) are *tripartite*, that is, formed of four pieces of unequal size so placed together that three only are visible on a front view, and are dispersed without order either through all the branches, or through the smaller ramuli, where, in some cases, they are collected in a sub-defined cluster near the apices. In this character is found the chief technical distinction between the *Bonnemaisoniæ* and the *Rhodomelaceæ*. The *Lomentariæ* are additionally known by the peculiar structure of the frond and the differences, indicated above, in the sporiferous nucleus.

The colour of the frond in this order is considerably varied in the different genera, and even in the same species under different circumstances. *Bonnemaisonia*, *Delisia*, and *Asparagopsis* (*Lictoria*) are of a most beautiful rosy pink; *Lomentaria* and *Champia*, when in good order, are a purple lake, sometimes reflecting rainbow hues; but their colours are fugacious and, when the fronds grow in sunny places, they very frequently are either greenish, yellowish or nearly colourless. The proper colour in most *Laurenciæ* is a lurid purple, in some brown-red; but light and exposure in shallow water call forth every shade of red, orange and yellow, and sometimes green, the same frond often being variegated with two or more of these tints. Almost all decompose rapidly in fresh water, especially if again moistened after having once been dried.

The substance of the frond is either cartilaginous or gelatinoso-membranaceous. The taste insipid or somewhat pungent. *Laurencia pinnatifida*, the *Pepper Dulse* of the Scotch, was or is eaten as a salad in parts of Scotland (*Lightf. Fl. Scot.* p. 954). According to Dr. Lindley, a large portion of what is now sold in the shops as *Corsican Moss* is *Laurencia obtusa*, which perhaps has equal virtues with the real *Helminthochorton*.

This order, though small, is widely dispersed, being represented under one form or other in almost every sea. *Laurencia* is peculiarly cosmopolitan in its distribution, and its common forms, *L. pinnatifida*, *obtusa*, &c. are found in the most oppo-

site regions of the ocean of both hemispheres. *Champia* (as here understood) is equally sporadic. *Lomentaria ovalis* is a native of the Pacific and Atlantic oceans. *Bonnemaisonia* is European; *Cladhymenia* and *Delisia*, Australian.

The natural limits of the order are variously understood by botanists, and I have the misfortune to differ from Prof. J. Agardh in my opinion on the subject. He admits two suborders, *Spongiocarpeæ* and *Solierieæ*, which do not appear to me to associate naturally with the other genera. *Spongiocarpeæ*, consisting of the remarkable genus *Polyides*, has a structure of frond and of fructification widely different from that of either of the suborders here retained, and also, in my judgment, from that of any other Desmiospermatous Order. The *Solierieæ*, consisting of *Solieria* and *Eucheuma*, appears to me to associate more naturally with *Hypnea*, and to connect that genus in some degree with *Gelidium*. I formerly admitted *Chrysymenia* and *Chylocladia*, J. Ag., and *Thysanocladia*, Endl. but the different structure of the nucleus in these genera, as has been well pointed out by Agardh, compels me to remove them elsewhere. Yet so similar in habit are some of the species of *Chylocladia* to some *Lomentariæ*, that almost all authors have confounded them. The presence of diaphragms in the frond is no certain test of a *Lomentaria*, as appears by *Chylocladia articulata*, whose sporiferous nucleus is identical with that of *Ch. clavellosa*.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

SUBORDER 1. BONNEMAISONIÆ, J. Ag. *Frond* solid. *Conceptacles* ovate. *Spores* pear-shaped, on simple spore-threads.

I. LAURENCIA.

SUBORDER 2. LOMENTARIÆ. *Frond*, at least the branches, hollow, constricted at intervals and divided internally, by transverse septa, into chambers. *Conceptacles* ovate or spherical. *Spores* obconic or roundish, sessile, or attached to much branched, confervoid, spore-threads.

II. CHAMPIA. *Conceptacles* ovate, with a terminal pore. *Spores* paniculate, on branching spore-threads.

III. LOMENTARIA. *Conceptacles* globose, without a pore. *Spores* sessile, or nearly so, obconical.

I. LAURENCIA, *Lamour.* J. Ag. ref.

Frond solid, cartilaginous, terete or compressed, decompound pinnate, rarely subdichotomous, composed of two strata of cells: the medullary stratum of oblong-angular longitudinal cells, longest toward the centre of the stem; the cortical of roundish angular cells in a subsimple row. *Conceptacles* ovate, with a terminal pore, containing within a cellular pericarp a dense tuft of pearshaped spores on simple funiculi radiating from a basal placenta. *Tetraspores* tripartite, lodged without order in a transverse band below the apices of the ultimate ramuli. *Antheridia* collected in terminal, saucer-shaped receptacles.

Fronds generally fleshy, rarely membranaceo-gelatinous when recent, cartilaginous when dry; often livid purple, rarely a blood or rose-red colour, changing to greenish or yellowish when growing in shallow water exposed to sunshine. *Stem* and *branches* linear, terete or compressed, pinnately compound, the lesser divisions sometimes irregularly forked, or subdichotomous, distichous or branched to all sides; the branches opposite, alternate or irregularly whorled; sometimes very irregularly placed. *Ramuli* slightly constricted at the base, dilated and very obtuse at the summit; the barren ones simply clavate, the fertile often by the development of rudimentary processes tuberculated or botryoid. *Conceptacles* formed from the transformation of the ultimate ramuli, mostly ovate. *Tetraspores* always lodged beneath the ends of the simple or compound ramuli.

From this genus, restricted by the above character, are now removed all the species (as *L. dasyphylla*, *L. tenuissima* and their allies) that have an articulated polysiphonous axis running through the frond. These will be found among *Rhodomelaceæ* under the genus *Chondria*. The remainder of the Grevillian genus *Laurencia* constitute a very natural group, dispersed through most parts of the temperate and tropical oceans. Very few occur on the shores of the Northern States, but on the Florida Keys there are many common species, some of them congregating in such masses that a large per centage of the drift seaweed is composed of their broken fronds.

The species are exceedingly difficult of determination. Many intermediate varieties often connect the most opposite looking specimens, and the new species here proposed are not offered without hesitation. Indeed, in this genus, as in many others, it is often impossible to tell whether we are dealing with species or sportive forms without a very careful examination of a number of specimens, or without some knowledge of the circumstances accompanying their development.

1. *LAURENCIA pinnatifida*, *Lamour.*; frond compressed, cartilaginous, dull purple, bi-tripinnatifid, all the divisions alternate, the ultimate ones obtuse, simple or lobed. *Harv. Phyc. Brit. t.* 55. *Kütz. Sp. Alg. p.* 856. *Harv. in Bot. Beech. Voy.*

p. 164 and 408. *Fucus pinnatifidus*, E. Bot. t. 1202. Turn. Hist. t. 20. *Laurencia spectabilis*, Post. and Rupr. p. 16 !

HAB. Monterey, California, D. Douglas, Dr. Coulter. (v. v.)

Root branching. *Fron*d, in the Californian specimens, 8-12 inches long, one to two lines in diameter, compressed below, becoming flatter and wider upwards, decompound-pinnate. *Stem* dividing below into several branches, which are naked in the lower half and there entire or dentate at the margin, and closely pinnate or bipinnate above. In smaller individuals the branches are simply pinnate, the pinnae from half an inch to an inch long, erecto-patent with rounded axils, alternate, at distances of the third of an inch apart, the upper ones somewhat opposite, crenate at the apex, the lower ones more and more pinnatifid. Fertile specimens are narrower, with subcylindrical laciniae. *Conceptacles* ovate, sessile, two or more on the ultimate laciniae. *Tetraspores* scattered toward the ends of the laciniae. *Colour* a livid purple, becoming brownish in drying. *Substance* opaque, densely cellular. It imperfectly adheres to paper.

Dr. Coulter's numerous specimens are undistinguishable from some of my West of Ireland examples, and I see no character by which *L. spectabilis* P. and R. of which I have examined an authentic specimen, can be separated from the common *L. pinnatifida*, which is well known to be very variable in size and branching.

2. *LAURENCIA virgata*, J. Ag. ; frond terete, pinnately branched ; the branches spreading to all sides, opposite or verticillate, elongate, simple, racemoso-pinnated with short secondary branches ; ramuli opposite or whorled, erect, simple or corymboso-paniculate ; the tetrasporiferous ones clavato-cylindrical. J. Ag. Sp. Alg. 2. p. 752.

HAB. Monterey, California, Dr. Coulter. (v. v.)

Dr. Coulter's specimens are about six inches high. Several stems as thick as sparrow's quill rise from a mat of branching fibres. They are generally bare of branches at the base for an inch or two, and set above with closely crowded lateral branches which are not strictly distichous in insertion. In the less divided specimens, the branches are either naked and filiform, or somewhat pinnated ; in the more compound they are twice or thrice closely pinnated, the general outline being pyramidal. The lower part of the frond is slightly compressed, its lesser divisions more and more terete, and the ultimate pinnules cylindrical, remarkably truncate, and slightly constricted at the base. *Tetraspores* are imbedded toward the ends of the ramuli. *Colour* a very dark lurid purple, becoming still darker in drying. *Substance* cartilaginous, and structure dense.

I venture to refer the Californian specimens above described to the *L. virgata* J. Ag. a species founded on individuals collected at the Cape of Good Hope. I have compared them with Cape specimens, with which they agree in most points, and I

am unwilling on slight discrepancies to multiply species in this genus. The probability of specific identity is the greater because many other Cape Algæ occur on the Pacific coast of America.

3. *LAURENCIA obtusa*, Lamour.; frond cylindrical, pinkish red or yellow, twice or thrice pinnate, the pinnæ very patent; ramuli mostly opposite (occasionally alternate or irregular) patent, short, truncate. *Harv. Phyc. Brit. t.* 148. *Kütz. Sp. Alg. p.* 854. *Fucus obtusus*, *Turn. Hist. t.* 21. *E. Bot. t.* 1201.

HAB. Florida Keys, parasitical on corals and Algæ. Key West, *W. H. H., Prof. Tuomey* (33, 40, 44, &c.) Apalachicola, *Capt. Pike* (69). Island of St. Catalina, California, *Lieut. Wood*, Brit. Navy. (v. v.)

Fronds in large subglobose tufts. *Stems* as thick as sparrow's quill, cylindrical, from one to six inches long, undivided or once or twice forked, decompound pinnate. *Branches* not strictly distichous, very patent, alternate or opposite, sometimes three from the same level, bi-tripinnate. *Pinnules* opposite, alternate, or in threes, cylindrical, truncate, very patent or subhorizontal, simple or with one or two pair of secondary pinnules. *Colour* in the stem and branches generally pale waxy yellow, with a reddish tinge, in the ramuli a beautiful pinky red. *Substance* cartilaginous, firm. In drying, it adheres pretty strongly to paper.

In the Florida specimens the ramuli are very frequently alternate, as sometimes occurs in those from Europe. Perhaps the following should be considered merely an exaggerated variety.

4. *LAURENCIA implicata*, J. Ag.; frond terete, slender, much branched, between pinnate and dichotomous, subfastigiate; the lesser branches very irregular, flexuous, patent; ramuli cylindrical, alternate or secund, simple or forked, truncate, slightly clavate. (TAB. XVIII. D.) *J. Ag. Sp. Alg.* 2, p. 745. *L. Forsteroides*, *Harv. in Herb. MSS.*

HAB. Key West, *W. H. H.* (36), *Prof. Tuomey* (23, 31, 50), *Dr. Blodgett* (54, 66.) (v. v.)

Tufts globose, dense. *Fronds* 4-5 inches high, as thick as sparrow's quill, excessively branched from the base, the branches spreading to all sides, decompound, irregularly forked, flexuous, alternately multifid above; their lesser divisions furnished with alternate or secund, cylindrical, scattered ramuli, two or three lines long, simple or forked. *Colour* a pinky red; orange or yellow in the branches, greenish on exposure and in decay. *Substance* cartilaginous. It adheres to paper in drying.

Only to be known from *L. obtusa* (of which it may be merely a variety,) by the irregular branching and much scattered, frequently secund ramuli. It seems in-

intermediate in character between *L. obtusa* and the Australian *L. Forsteri*, Grev. (*Turn. Hist. t.* 77.)

Plate XVIII. D. *Fig. 1.* *LAURENCIA implicata*; a branch, the *natural* size. *Fig. 2,* a portion, somewhat *magnified*.

5. *LAURENCIA cervicornis*; frond terete, robust, irregularly branched, subdichotomous; the secondary branches curved upwards, spreading to all sides, having a few secund, cylindrical, obtuse ramuli; axils rounded; conceptacles broadly ovate with a projecting orifice, sessile near the tips of the ramuli. (TAB. XVIII. C.)

HAB. Key West, *W. H. H.* (31), *Dr. Blodgett*.

Tufts globose, somewhat fastigate. *Fronde*s as thick as crow's quill, 4-5 inches long, much branched from the base, bushy, very irregular in ramification, the branches spreading widely and directed to every side, curved upwards, of somewhat equal height, making a loosely corymbose head, naked, or having along their upper side, at distances of a quarter to half an inch, several cylindrical, secund ramuli. *Ramuli* erecto-patent, obtuse, quite simple or ramulose at the tip, from a quarter to half an inch long or more. *Conceptacles* at or near the ends of the branches, partly imbedded, very broad in proportion to their length, with a projecting, acute orifice. *Colour* a dark brownish red. *Substance* rigid, scarcely adhering to paper.

Seemingly allied to *L. Forsteri*, but more robust than the strongest grown specimens of that species, and less dichotomous.

Plate XVIII. C. *Fig. 1,* a branch of *LAURENCIA cervicornis*, the *natural* size. *Fig. 2,* apex of branch, with conceptacle; *fig. 3,* spore; both *magnified*.

6. *LAURENCIA gemmifera*; fronds robust, cartilaginous, fragile, terete, flexuous, irregularly much branched; branches patent, alternate, unequal, irregularly pinnate or bipinnate, set throughout with minute, bud-like, horizontal, scattered, spirally disposed, truncate ramuli. (TAB. XVIII. B.) β . decompound-pinnate, the pinnæ tolerably regular and very patent.

HAB. Florida Keys. Key West, *W. H. H.* (34), *Dr. Blodgett* (36) var. β . Key West, *W. H. H.* (30), *Prof. Tuomey* (30, 38, 53), *Dr. Blodgett* (49). (v. v.)

*Fronde*s growing in large, loose bundles, 6—8 inches long, as thick as crow-quill, shrinking in drying, much and very irregularly branched, the branches spreading toward every side, and subspirally inserted, alternately or irregularly scattered, very flexuous, having secondary branches at distances of a quarter to half an inch. These branches are of very unequal length, long and short intermixed, and are patent, with rounded angles, and much curved or arched, and sprinkled throughout with exceedingly minute, bud-like ramuli. *Ramuli* spirally disposed round the

branches, horizontal, truncate, very short, simple or tubercled, sometimes slightly longer and pinnulate. *Colour* of the branches pale red or waxy yellow. *Substance* cartilaginous and brittle. In drying, the plant shrinks much, and very imperfectly adheres to paper.

What I call var. β . differs from the normal form in being more regularly pinnate and bipinnate, with closer branches. It is also of a brighter colour, and its ramuli are sometimes expanded at the apex into perforate or umbilicate cups, and rather more compound than in var. α .

This plant grows commonly at Key West in shallow water between tide-marks on the north side of the town. I cannot refer it to any described species. It is much more robust than *L. obtusa*. Its very flexuous irregular ramification, bud-like ramuli and brittle substance distinguish it from other Key West species.

7. *LAURENCIA papillosa*, Grev.; fronds terete, cartilaginous, sub-pinnate or irregularly decompound; branches filiform, simple, densely covered with short, quadrifarious, horizontal, simple or lobed papilliform ramuli; conceptacles ovate, sessile. *J. Ag. Sp. Alg.* 2, p. 756. *Chondria papillosa*, *Ag. Sp. Alg.* vol. 1, p. 344. *Fucus thyrsoides*, *Turn. Hist. t.* 19.

HAB. Florida Keys. Key West, *Mr. Binney*, *W. H. H.* (33), *Prof. Tuomey*, (54, 56, 57). (v. v.)

Fronds tufted, 4—6 inches long, as thick as a sparrow's or as a crow's quill, terete, undivided or vaguely forked, naked below, branching above. *Branches* directed every way, either distant or densely crowded, simple, one to three inches long, virgate, tubercled with close-set quadrifarious, wart-like ramuli, which in old specimens are multifid and much distorted. *Colour* a dull purple, changing to green. *Substance* firmly cartilaginous. In drying, it scarcely adheres to paper.

Somewhat variable in ramification and in size, but readily known by the densely crowded, wart-like ramuli with which the branches are completely covered. In old specimens these ramuli are much compounded, and resemble miniature heads of cauliflower.

8. *LAURENCIA scoparia*, J. Ag.; "greenish, somewhat horny; frond terete, filiform, distichously decompound; branches irregularly set, erecto-patent, some opposite, some secund, virgate; fertile ramuli, very short, tufted at the apices of the branches, subclavate, bearing tetraspores under the truncate apices." *J. Ag. Sp. Alg.* 2, p. 746.

HAB. La Guayra, *Herb. Binder*.

"Two to four inches high, densely tufted, rigid, with the substance and nearly the habit of *Ahnfeltia plicata*. Frond as thick as sparrow's quill, very much branched."

9. *LAURENCIA tuberculosa*, J. Ag. ; "rosy purple, frond compressed, distichously decompound-pinnate ; pinnæ on a straight, excurrent rachis, alternate, patent ; the medial pinnules similar, the lower short, transformed into roundish, tuberculated warts, bearing tetraspores lodged in the tubercles." *J. Ag. Sp. Alg.* 2, p. 760.

HAB. Vera Cruz, *Liebman*.

"*Frond* 4—6 inches long, as thick as a pigeon's quill, subterete or slightly compressed, alternately and distichously bi-tri-pinnate ; rachides scarcely conspicuously flexuous, obtuse, prolonged, naked beyond the pinnæ. Primary pinnæ 3—4 inches long, secondary an inch and half."

II. CHAMPIA. *Desv.* *Harv. ref.*

Frond terete or compressed, branched, tubular, constricted at intervals, and furnished internally at the constrictions with transverse membranous diaphragms which divide the tube into chambers ; diaphragms connected by a few longitudinal, confervoid filaments ; walls of the frond composed of polygonal cellules, in one or many rows. *Conceptacles* ovate, with a terminal pore. *Placentæ* one or many, basal, much branched, confervoid, connected with the walls by confervoid threads, and bearing on the ends of the branches densely crowded ovoid or obconic *spores*. *Tetraspores* tripartite, scattered through the superficial cells of the branches and ramuli.

The genus now called *Champia* was founded in 1804 by Thunberg under the name *Mertensia*, a name previously given by Dr. Roth (1797) to a well-known Boragineous plant of North America. Thunberg's original species, *Ch. lumbricalis*, a native of the Cape of Good Hope, remained for about thirty years the sole member of the genus ; but recently two others, *C. compressa* from the Cape, and *C. Tasmanica* from Van Dieman's Land, have been added. These three constitute the genus *Champia* as generally understood by algologists, and as it appears restricted by Prof. J. Agardh in his *Sp. Alg.* vol. 2, p. 368. I venture now to add to them such species of *Lomentaria* of authors (*Chylocladia* of Greville and other British writers) as have ovate conceptacles furnished with a terminal pore ; because I find, on carefully examining their sporaceous nucleus, that it is formed exactly on the type of that of *Champia lumbricalis*, and not at all as in *Lomentaria kaliformis*, the type of the true *Lomentariæ*. In our *Ch. parvula* and *Ch. salicornoides* the placenta is less paniculate than in *Ch. lumbricalis*, but nevertheless is much branched, as

may readily be seen if a conceptacle from which the spores have been shed be carefully dissected. The placenta in such conceptacles will be found not unlike a bird-cage or the open net-work of a clathroid fungus, nearly filling the cavity, and connected with the surrounding walls by cross threads. This is precisely the structure in *Ch. lumbricalis*, *compressa* and *Tasmanica*, as well as in *Chylocladia affinis*, Harv. (*Ner. Austr. t. 29*), which therefore I now remove to *Champia*. *Chylocladia Novæ Zealandiæ*, Hook. and Harv., whose conceptacles are unknown, is probably also a *Champia*. The genus so constituted forms a natural group, all the species having a constricted frond divided into loculi by transverse septa. I differ with my friend Prof. J. Agardh in regard to its nearest affinities; he referring his *Champia* to the neighbourhood of his recently amended genus *Chylocladia* (founded on *Chrysymenia clavellosa* of his former writings), whilst I am of opinion that it is much more nearly connected with *Lomentaria*.

1. *CHAMPIA parvula*, Harv.; tufts globose, dense; frond irregularly branched, ramuli scattered; branches and ramuli constricted at intervals of once or twice their diameter; conceptacles scattered. *Chylocladia parvula*, Grev. Harv. *Phyc. Brit. t. 210*. *Lomentaria parvula*, Zanard. *J. Ag. Sp. Alg. 2, p. 729*. Kütz. *Sp. Alg. p. 864*.

HAB. On the smaller algæ, &c. between tide marks. Nantucket, *Miss Mitchell*. Seaconnot, Newport and Narragansett Pier, *Prof. Bailey* and *Mr. Olney*. Peconic Bay, *Prof. Bailey* and *W. H. H.* Hellgate, New York, *Mr. Hooper* and *Mr. Congdon*. Key West, *W. H. H.*, *Dr. Blodgett* (71) and *Prof. Tuomey* (38). (v. v.)

Tufts globose, often intricate, two to four inches in diameter. *Fronds* as thick as sparrow's quill, very irregularly branched; the branches sometimes somewhat pinnately compounded, all or most of the divisions alternate; sometimes and more frequently several times irregularly forked below, and inordinately branched above. Branches and ramuli very patent, linear, ending in a blunt point. The main divisions are either regularly constricted and septate throughout, at intervals of once and half their diameter, or are sub-cylindrical and obsoletely constricted in the lower part; all the lesser branches and ramuli are obviously articulato-septate. *Conceptacles* scattered over the branches, very prominent, conical or ovate, thick-walled. *Colour* brownish red, purplish, or waxy yellow. *Substance* softly cartilaginous. It closely adheres to paper in drying.

A variable plant. Most of our specimens nearly agree with common European varieties. One, received from Mr. Congdon, is more pinnate than the others, and rather more robust. Another variety found by Mr. Hooper at Greenport is much more slender than usual, scarcely thicker than hog's bristle, with the constrictions obsolete, or not visible without close examination. I have British specimens nearly similar.

2. *CHAMPIA salicornoides*; frond cylindrical and inarticulate at the base, nodoso-constricted upwards, whorled with one or more sets of short moniliform, obtuse

branches ; internodes about as long as broad ; conceptacles conical, scattered. (TAB. XIX. B.)

HAB. At Key West, *W. H. H.* (27), *Dr. Blodgett* (72). (v. v.)

Root discoid. *Fronds* two or three inches high, about a line in diameter, tufted. *Stems* at first filiform, cylindrical and solid for half an inch or more, then distended and either continued as a single articulo-constricted simple stem, or dividing into a tuft of such stems. These *upper* stems are regularly constricted at short intervals, and are thickest in the middle and gradually taper to the base and apex. *Branches* opposite or whorled, similarly constricted, the lowest longest, and in fully developed specimens furnished with a second or third series of shorter branches and ramuli. All the lesser divisions are nodose, the internodes about as long as broad. The conceptacles are conical, scattered over the ramuli, their walls very thick and the sporiferous nucleus very densely tufted. *Tetraspores* very minute, dispersed through the ramuli. *Substance* softly cartilaginous. In drying it closely adheres to paper.

This has a habit very similar to that of *Lomentaria Mediterranea*, J. Ag. with which I had at first confounded it, but it is readily distinguished by its very different conceptacles, the nucleus of which is not correctly given in our plate, *figs.* 5, 6, which were taken from a hastily examined and imperfect specimen. The structure of the sporiferous nucleus is exactly the same as in *Ch. parvula*, from which this species differs very much in ramification. I gathered very few specimens at Key West.

Plate XIX. B. *Fig. 1.* *CHAMPIA salicornoides*, the *natural* size. *Fig. 2.* section of a branch to show the hollow chambers and diaphragms ; *fig. 3.* branch with conceptacles ; *fig. 4.* a conceptacle ; *fig. 5.* section of the same (the contained nucleus incorrectly drawn) ; *fig. 6.* nucleus (incorrect) ; *fig. 7.* spores ; all more or less *magnified*.

III. LOMENTARIA. *Endl. excl. sp.*

(GASTRIDIVM, *Lynb.* CHYLOCLADIA, *Grev. ; Harv. Phyc. Brit. excl. sp.*)

Frond (at least the branches) tubular, constricted at regular intervals and divided by internal membranous diaphragms into chambers filled with a watery juice and traversed by a few longitudinal confervoid filaments ; walls of the frond composed of polygonal cellules in one or many rows. *Conceptacles* spherical, without orifice : *sporiferous nucleus* globose, very dense, consisting of many obconic, subsessile spores radiating from a minute basal placenta. *Tetraspores* tripartite, scattered through the superficial cells of the branches and ramuli.

The type of this genus, restricted by the above diagnosis, is *Fucus kaliformis*, Good and Woodw. (*Chylocladia kaliformis*, Grev. and of other British writers,) to which are added the other species of the Grevillean genus *Chylocladia*, which have similarly organised conceptacles. In the structure of the frond there is a very close affinity with *Champia*, but the difference in the sporiferous nuclei in the two genera is too important to admit of their union. A still greater difference in the fructification separates the reformed genus *Chylocladia*, as now understood by Prof. J. Agardh.

I adopt the name *Lomentaria* for the present genus in deference to the authority of Endlicher, Montagne, Kützinger, and J. Agardh, and in order to avoid confusion in nomenclature; but it unfortunately happens that *L. articulata*, Lyngb. the plant originally called *Lomentaria* by Lyngbye, and to which he restricted his genus, must be removed from the modern genus as at present adopted by botanists. Dr. Greville, long ago (Alg. Brit. p. 114) remarked that his genus *Gastridium*, afterwards called *Chylocladia*, included two generic types, indicated by differences in fructification, a character which, at the time he wrote, was not considered of sufficient importance apart from others, to justify the dismemberment of the genus. One of these types, comprising *Ch. kaliformis*, *ovalis*, and others with similar fructification, constitutes the modern *Lomentaria*; the other, comprising *Ch. clavellosa*, *articulata*, and others, the reformed genus *Chylocladia*, J. Ag. Now should the spirit of genus-splitting proceed further at a future time, and *Ch. articulata*, on account of its articulated frond, be separated from the species of *Chylocladia* with tubular fronds, it must either receive a new name, or if its old one, *stolen* for the present genus, be restored to it, we shall have to find a name to supply the deficiency, and perhaps *Gastroclonium* of Kützinger may then be applied to the group typified by *Ch. kaliformis*.

1. *LOMENTARIA ovalis*, Endl.; frond cylindrical, solid, irregularly dichotomous, naked below, above beset with simple, elliptical, or elongated and nodoso-articulate tubular ramuli. *Harv. Phyc. Brit. t.* 118. *Gastroclonium ovale*, Kütz. *Sp. Alg. p.* 865. Var. β . *Coulteri*; frond robust, livid purple, with very obtuse, obovate, simple ramuli. (TAB. XIX. A.) Var. γ . *subarticulata*, Turn.; ramuli long, linear, contracted and jointed, *Turn. Hist. t.* 81, n.

HAB. On the Pacific Coast. β . at Monterey, California, *Dr. Coulter*. γ . Nootka Sound, *Mr. Menzies*, 1787. (v. s. in Herb. T. C. D.)

In *Dr. Coulter's* specimens the stems are tufted, six to eight inches high or more, cylindrical, solid, thicker than crow-quill, dichotomous, flexuous with rounded axils. Branches erect, somewhat corymbose, sparingly divided, usually naked for the greater part of their length, densely beset near the summit with elliptic-oblong or clavate, simple, hollow, very obtuse ramuli, and here and there furnished with a few short, lateral branchlets ending in a tuft of similar bag-like ramuli. The walls of the ramuli are thick, composed of several rows of angular, coloured cellules.

Conceptacles not seen. *Tetraspores* of large size are scattered through the walls of the ramuli. *Colour*, judging from dried specimens, a dark lurid purple, turning greenish in decay. *Substance* tough, rigid when dry. In drying, it does not adhere to paper.

This is of firmer and more rigid texture and of darker colour than the ordinary European *L. ovalis*, and at one time I considered it specifically distinct. Recently I have seen and examined Mr. Menzies' Nootka specimen, which is much more like some of the dwarf English states of the species, and I am now of opinion that it is better to retain my *L. Coulteri* as a variety only.

There is much agreement in external habit between *L. ovalis* and *Chrysymenia uvaria*, but the fructification is widely different.

PLATE XIX. A. *Fig. 1*, *LOMENTARIA ovalis* var. *Coulteri*, the natural size. *Fig. 2*, a ramulus with tetraspores; *fig. 3*, small portion of a section of the wall of the same; *fig. 4*, cross section of one of the solid branches.

2. *LOMENTARIA*? *saccata*, J. Ag.; "Stem solid, short, densely branched, supporting obovate, vesicular ramuli attenuated at base into a slender petiole; tetraspores scattered through the ramuli; conceptacles numerous, approximate, scarcely hemispherical, inflated, sub-immersed." *J. Ag. Sp. Alg.* 2, p. 738. *Dumontia saccata*, *Grev. MS.*

HAB. California, Herb. *Greville*.

"Stems scarcely an inch high, as thick as a pigeon's quill, terete, solid, irregularly much-branched. *Ramuli* sub-heterogeneous, emerging from the branches, borne on setaceous petioli, saccate, resembling obovate, ellipsoid, inflato-tubulous bags, collapsed when dry, three to ten lines in length, and two to six in diameter. *Conceptacles* densely aggregated. *Colour* a blackish purple. *Substance* of the stem car-noso-cartilaginous; of the ramuli membranaceous."

This species is wholly unknown to me.

ORDER III. CORALLINACEÆ.

Corallineæ, Lamour. *Cor. Class.* p. 244. *Dne. Class.* p. 63. *Endl. 3d. Suppl.* p. 48. *Harv. Ner. Austr.* p. 92. *Lindl. Veg. King.* p. 25. *Corallineæ and Spongiteæ*, Kütz. *Phyc. Gen.* pp. 387, 385. *Kütz. Sp. Alg.* pp. 695, 699. *Corallinidæ and Nulliporidæ*, Johnst. *Brit. Lith.* p. 205.

DIAGNOSIS. Rigid, stony, articulated or crustaceous, mostly calcareous sea-weeds, purple when recent, fading, on exposure, to milk-white, composed of closely packed, elongated cells or filaments, in which carbonate of lime is deposited in an organized form. *Spore-threads* short, tufted in the base of encysted conceptacles, furnished with a terminal pore, simple, each thread at length separating into four *spores*.

NATURAL CHARACTER. *Root*, when manifested, an expanded, crustaceous disc, often spreading widely over the rock or shell to which it is attached. *Fronde* calcareous, effervescing strongly when thrown into acid, the cells of which it is composed secreting carbonate of lime in an organized form within their walls, and calcareous matter being also deposited on the surface of the cells and between their interstices. The whole compound frond then appears to the eye as if coated with enamel, and when broken, seems equally stony within. On maceration in acid, the rigid substance becomes soft and pliable, and sub-transparent, and the cellular tissue is obtained free from lime. The cells composing the axis or medullary part of the stem are long, slender and vertical, either closely packed together and overlapping at the ends, or disposed in filamentous series. Those which immediately surround this central layer are shorter and curved outwards, and the cells of the periphery are very minute. A longitudinal section of the stem has frequently a transversely banded appearance, from the cells of which it is composed being nearly of equal length and so placed that their ends stand on a level.

In outward habit there is considerable variety among these plants. The lowest forms of the order are simply incrustations, spreading like the least organized of the crustaceous lichens, over the surface on which they grow, and like them usually extending from a central point in successive concentric circles of growth. Some are mere films, as thin as tissue paper; others are thick and stone-like, the crust rising into prominences or sinking in depressions. The surface of the thicker crusts is very frequently papillated with conical wart-like prominences, scattered or densely aggregated. In the more advanced kinds these lengthen into cylindrical processes, and become branched, the branches often so densely crowded that little more than their ends are visible, in which case the

mass resembles a stony head of cauliflower, or some of the incrustations of similar aspect so often seen in calcareous spar caves. Others are more shrub-like or arborescent, and in others the branches become compressed, or flattened into leafy lobes. In the genus *Mastophora*, the most leaf-like plants of the Order, there is less carbonate of lime deposited than in most others, and the fronds are proportionably flexible; they are fan-shaped, with fastigate leafy laciniae, and have a habit very similar to that of some species of *Zonaria*. All the above varieties of form are found in the sub-order *Nulliporeæ* (*Spongiteæ*, Kütz). The true Corallines or *Corallineæ* are filiform, somewhat compressed, pinnated or dichotomous, the branches composed of strings of calcareous articulations or internodes, truncated at the upper extremity and rounded at the lower, each articulation connected with that above and below it by a flexible node or joint formed of cellular tissue, in which no calcareous matter is deposited. In the majority, the calcareous internodes are separated by minute flexible nodes, often hidden under the projecting edges of the internode, and only to be seen on close examination. But in some species of *Amphiroa* the flexible node is elongate, and even occasionally longer than the calcareous internode, the branches of such species looking like a number of beads or *bugles*, distantly placed on a connecting thread. In some of these latter the surface of the node is occasionally armed with minute calcareous plates or tubercles. The form of the internode varies extremely; often in the same species; or even in different parts of the same individual, in which it is common to find the articulations of the stem, the branches and the ultimate ramuli having distinct forms. In many the internodes are cylindrical; in others oval or compressed; in others flat and with an irregular outline; but the most common forms are cordate and cuneiform, the upper angles or shoulders of the internode often extending into ears or horns.

The fructification is not perfectly ascertained, and the position and affinities of the order are therefore uncertain. It is not without hesitation that I now give the name of *four-jointed spore-threads* to the little bodies found tufted in the base of the conceptacles, and which in another place (Phyc. Brit. t. 201, 222, 252) I have figured and described as *zonate tetraspores*. If we are to judge of their nature by their *aspect*, we shall certainly, with Decaisne and other writers, regard them as *tetraspores*; but if by the position they occupy within conceptacles formed on the type of those of *Polysiphonia*, we shall pronounce them *spore-threads*. If they were not four-parted, they would very closely resemble the *spore-threads* of a *Polysiphonia*; and they occupy a place exactly similar, being transformations of the same parts of the frond, and similarly protected within conceptacles, whose form and origin are identical with those of the conceptacles in *Polysiphonia*. So that *morphologically* speaking, we are compelled to regard them as *spore-threads*. If this be their real nature, it may be worth enquiry whether the supposed *tetraspores* of *Phacelocarpus* and *Apophleæ* are not to be regarded as strings of spores, being found lodged within hollow conceptacles, to the walls of which they are attached. I am aware that other conceptacles have been described in *Phacelocarpus*, but after an examination of many specimens I have failed to detect perfect spores within them, and consequently consider them as merely abortive efforts at fructification; an

opinion rendered more probable by their *position*, which is the same as that of the fertile branchlets.

The conceptacles in the Corallineæ are either formed out of the terminal articulations of the lesser branches, as in *Corallina* and *Jania*; or on some part of the surface of the middle and lower articulations, as in *Amphiroa*. But frequently spurious conceptacles, equally furnished with spore-threads as the normal ones, sprout out irregularly from any part of the stem or branch. This I have repeatedly observed in *Corallina squamata* and *C. officinalis*, whose whole surface is sometimes densely warted with such irregular fructification.

The Corallinaceæ, under some form or other, are dispersed through most parts of the ocean, and at depths varying from the highest level of ordinary tides to many fathoms below low-water mark. The crustaceous kinds in particular abound on the stones and in shallow places, where, however, they seldom exhibit more than an expanded crust. Within the tidal limits, from the level of half-tide to low-water mark, they flourish, fruiting abundantly. Beyond the tidal limit, in water of 5, 10, 15, or even 50 fathoms in depth, they are still numerous, and frequently constitute vast banks, made up of unattached fronds heaped together without order, of which those alone on the surface of the bank are in a vegetating state. In such places, though the frond is very luxuriant, fructification is seldom formed. It is extremely probable that many of these deep-water forms, now regarded as specifically different from those found within tide marks, are merely barren varieties of the tidal species, altered by a different locality. The true corallines are very rare in the colder sea, in which alone *C. officinalis* attains a very high latitude. They are more abundant towards the tropics, and seem to be particularly numerous and beautiful on the shores of the Australian continent. As yet we can claim few within the limits of the North American Flora, but probably when the Pacific coast shall have been explored many new species will reward the collector. On the whole, the order is greatly more numerous in the Pacific than in the Atlantic Ocean.

Until recently the *Corallinaceæ*, and other calcareous Algæ, such as *Halimeda*, were confounded with the polypiferous Zoophytes, with which division of the animal kingdom they had been united by Ellis, who, nevertheless, figures the *spore-threads* of *C. officinalis* with his usual care.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

SUB-ORDER I. CORALLINÆ. *Frond* filiform, pinnate or dichotomous, jointed.

I CORALLINA. *Conceptacles* terminal, urceolate, simple. *Frond* pinnated.

II. JANIA. *Conceptacles* terminal or axillary, turbinate, tipped with two horn-like ramuli. (*Frond* in our species dichotomous.)

III. AMPHIROA. *Conceptacles* conical, scattered on the surface of the middle and lower articulations.

SUB-ORDER 2. NULLIPOREÆ. *Frond* crustaceous, foliaceous or shrubby, not jointed.

IV. MELOBESIA.

I. CORALLINA, L.

Frond filiform or compressed, calcareous, articulated, mostly pinnate. *Nodes* very short, striæform. *Conceptacles* ovate or urceolate, formed from the terminal articulation of the branches and ramuli, furnished with an apical pore, and containing in the base of the cavity a tuft of erect, pyriform or club-shaped, at length four-parted spore-threads.

1. *CORALLINA officinalis*, Lin. ; decompound pinnate ; the lower articulations cylindrical, twice as long as broad ; the upper slightly obconical, round-edged (not ancipital), their upper angles blunt ; the ultimate ramuli cylindrical, obtuse. *Harr. Phyc. Brit. t. 222. Kütz. Sp. Alg. p. 705.*

HAB. On stones and shells. Halifax, W. H. H. (v. v.)

Fronds two to four inches high, twice as thick as hog's bristle, distichous, decompound pinnate. *Branches* pinnate or bi-pinnate, especially at the top, sometimes naked below, often fastigiate or corymbose, erecto-patent ; pinnules mostly simple, attenuate. *Articulations* of the stem as long or twice as long as broad, sub-cylindrical ; of the branches more or less cuneiform, with rounded shoulders ; of the ramuli linear, cylindrical, or compressed, the terminal one either obtuse or pointed. *Conceptacles* formed either from the terminal articulation of a pinna, or from the surface of any of the articulations of the stem or branches, ovate. *Colour* dark lurid-purple when growing, becoming chalk-white when bleached.

A very variable plant, according to the depth of water at which it vegetates. It is probably common on the American shores, though I have not received it from my correspondents.

II. JANIA, Lamour.

Frond filiform or compressed, calcareous, articulated, dichotomous, or (in some Australian species) decompound pinnate. *Nodes* very short, striæform. *Concept-*

tacles urn-shaped, formed from the axillary articulation of the uppermost branches (mostly two-horned), furnished with an apical pore, and containing in the base of the cavity a tuft of erect, pyriform or club-shaped, at length four-parted spore-threads.

This genus scarcely differs from *Corallina*. The species are generally smaller and more slender, and those of North America are dichotomous, at least in the main divisions, and therefore easily known from the pinnated Corallines. Many of the Australian species of *Jania*, comprising the section *Haliptilon*, are however decompound pinnate.

1. *JANIA rubens*, Lamour. ; frond dichotomous, fastigiate, setaceous ; articulations of the principal branches and ramuli cylindrical, about four times as long as broad. *Harv. Phyc. Brit. t.* 252. *Kütz. Sp. Alg. p.* 709.

HAB. At Key West, *W. H. H.* (v. v.)

Fronds half an inch to an inch high, densely tufted, many times forked, as thick as hog's bristles ; branches erect or spreading, gradually tapering to the extremities. *Articulations* cylindrical in all parts of the frond ; those near the base very short, the upper ones gradually longer ; those in the middle region from four to five times as long as broad. *Colour* a pale red.

2. *JANIA Cubensis*, Mont. ; frond dichotomous, fastigiate, setaceous, the branches naked or pinnated with short, simple or forked, opposite ramuli ; articulations of the lower branches subcylindrical, of the upper cuneate with rounded shoulders, of the ramuli cylindrical, three or four times as long as broad. *Kütz. Sp. Alg. p.* 709.

HAB. Parasitical on *Digenia simplex*, and other Algæ, at Key West, *W. H. H.*, *Prof. Tuomey* (71).

Tufts dense, an inch in height, fastigiate, often spreading widely. *Fronds* as thick as hog's bristle, dichotomously divided, the branches patent or sometimes recurved, either destitute of ramuli (when the plant is hardly to be known from *J. rubens*) or pinnellated throughout with short ramuli, one or two lines in length. *Ramuli* distichous, or three together, simple and spinelike or forked, sometimes trifurcate and now and then lengthened and pinnellated. *Articulations* in the lower part subcylindrical, the upper ones more cuneate. *Colour* a dull red.

My specimens seem to agree very closely with a small authentic specimen kindly communicated to me by Dr. Montagne.

3. *JANIA capillacea* ; minute, dichotomous, capillary, with wide axils ; branches

recurved, squarrose; articulations cylindrical, four to six times as long as broad.

HAB. Bahia Honda, *Prof. Tuomey*. (70). (v. s. in Herb. T. C. D.)

I cannot satisfactorily refer the specimen received from Prof. Tuomey to any described species. It most resembles *J. rubens* in written character, but is much smaller and more slender, having more the aspect of *J. antennina*, Kütz. from which its much longer articulations separate it.

III. AMPHIROA. *Lamour*.

Frond terete, compressed, or flat, calcareous, articulated, dichotomous or pinnated. *Nodes* cartilaginous, more or less evident, sometimes elongate, naked or covered with tubercles. *Conceptacles* conical, wartlike, sessile on the disc of one of the articulations, furnished with an apical pore, and containing in the base of the cavity, a tuft of erect pyriform, at length four-parted spore-threads.

An extensive genus, chiefly found in the Southern and Pacific Oceans, where many of the larger and more beautiful species abound. A few occur in the Mediterranean, and in the Tropical Atlantic. There is much variety of habit among them, and Decaisne has divided the genus into four subgenera, two only of which are represented in the North American Flora. The species of the first subgenus have a habit quite peculiar, and are much more brittle than any other of the jointed Corallines. Those of the second group have the habit of *Corallina*, from which they are only to be known by the fructification.

SUB-GENUS 1. *Euamphiroa*. *Articulations* linear, elongate, terete or subcompressed. *Conceptacles* scattered, numerous.

1. AMPHIROA *fragilissima*, Lamour.; frond dichotomous, robust, attenuated upwards, very fragile; the axils wide, and branches spreading; articulations cylindrical, smooth, four or five times as long as broad. *Lamour. Cor. p.* 298. *Kütz. Sp. Alg. p.* 700. *Ellis and Soland. Cor. t.* 21, *fig. d.* (not characteristic).

HAB. Florida Keys. Key West, *W. H. H.* (v. v.)

Fronds 2—3 inches high, very fragile, as thick as sparrow's quill below, gradually

attenuated upwards, many times dichotomous, the articulations below the fork bifid at the apex, each lobe running out into the commencement of the arms of the forks. *Axils* wide. *Branches* divaricate. *Articulations* cylindrical, smooth, not swollen at the extremities, the nodes very short, indicated by a line only. *Colour* livid purple, fading to dirty white.

An exceedingly fragile species, of which it is almost impossible to preserve more than broken fragments.

2. *AMPHIROA debilis*, Kütz.; frond setaceous, dichotomous, fastigate, very fragile; branches divaricating; articulations many times longer than broad, cylindrical, thickened at each extremity; conceptacles numerous, subsecund. *Kütz. Sp. Alg.* p. 700.

HAB. Florida Keys. Key West, *W. H. H.* (v. v.)

Fronds 1—2 inches high, as thick as hog's bristle, repeatedly and pretty regularly dichotomous, occasionally trichotomous, the articulations below the dichotomy similar to the rest (not bifid or two branched). *Branches* spreading to all sides. *Articulations* generally but one between each furcation, cylindrical, those of the lower and middle regions of the frond incrassated at each end, the upper ones not so. *Interstices* or nodes simple, scarcely uncovered. *Conceptacles* numerous on the lower articulations, generally several ranged along one side of the internode.

A much smaller plant than the preceding, with differently shaped articulations. I have not seen any authentic specimen of Kützing's plant, which came from Cuba, but my specimens collected within eighty miles of Havana seem sufficiently to agree with his description.

3. *AMPHIROA cretacea*, Endl.; "dichotomous, diffuse, thick, chalky or ash-coloured; articulations cylindrical, approximate, 1–2 lines long, once and a-half or twice as long as their diameter; branches distant, flexuous and recurved, cylindrical or conical at the apex." *Kütz. Sp. Alg.* p. 701. *Post. and Rupr. Illustr.* p. 20. t, 40, *Fig.* 104.

HAB. Unalaschka, *Postels and Ruprecht.*

SUB-GENUS 2. *ARTHROCARDIA*. *Articulations* strongly compressed, frequently winged at the sides, cuneate or obcordate. *Conceptacles* conical, scattered.

4. *AMPHIROA* (*ARTHROCARDIA*) *Californica*, Dne. (?); subdichotomous or irregularly branched; articulations strongly compressed, with a sub-evident midrib, the lowermost cuneate, the upper broadly obcordate with blunt upper angles; conceptacles two to four on each fertile articulation. *Dne. Corall.* p. 112? *Kütz. Sp. Alg.* 704. *A. Hookeri*, *Harv. in Hook. Herb.*

HAB. Monterey, *Decaisne*. St. Francisco, *Barclay*. (v. s. in Herb. T. C. D.)

The St. Francisco specimens are three or four inches long, twice or thrice irregularly forked, the ultimate divisions dichotomous, the lower ones irregularly pinnated with numerous, lateral, simple branches. All the articulations are strongly compressed, the sides depressed, the central part raised and rib-like; the lower ones of the larger branches as well as of the lower divisions are cuneate, the upper gradually broader and more cordate, with much produced but rounded upper angles; the terminal articulations narrow. *Conceptacles* large, on my specimens generally in pairs on each articulation, but sometimes four or five on the lower ones.

I have not seen any authentic specimen of the plant of Decaisne, who describes it thus; "dichotomous; articulations compressed, and frequently cuneate, and generally furnished with four conceptacles on each face:" characters which do not strictly apply to my specimens, which nevertheless, I hesitate to describe as new.

5. AMPHIROA (ARTHROCARDIA) *tuberculosa*, Endl.; "dichotomous; dirty white or rosy violet; lowest articulations subterete, once and half as long as broad, upper dilated, more or less deeply obcordate, uppermost sub-approximate, irregularly cuneate-rhombic, sometimes linear, tuberculated at the back and margin; some of the tubercles perforated; branches scattered, subsimple, clavate or emarginate at the apex." *Kütz. Sp. Alg. p. 704. Corallina tuberculosa, Post. and Rupr. Ill. p. 20, t. 40, fig. 100.*

HAB. Island of Sitcha, *Postels and Ruprecht*.

I have seen no specimen of this or of the preceding species.

MELOBESIA. *Lamour*.

Frond attached by its lower surface or free; either flattened orbicular, sinuated or irregularly lobed; or cylindrical and branched; never articulated, coated with a calcareous deposit. *Conceptacles* conical, scattered over the surface of the fronds or partly immersed, furnished with an apical pore, and containing in the base of the cavity a tuft of erect, oblong, four-parted spore-threads.

The North American species of this genus have not yet been carefully examined or collected. Probably several occur along the coast, and will be found either encrusting tidal rocks or stones, or lying at the bottom of harbours in from five to

twenty fathom water. Authors enumerate many forms which are probably but variable shapes assumed by the same species at different times. Thus *M. membranacea*, *farinosa*, *verrucata* and *pustulosa* of Lamouroux, appear scarcely to differ from each other except in age and luxuriance. By Dr. Johnston the whole are regarded as abnormal states of *Corallina officinalis*.

ORDER IV. SPHÆROCOCOIDEÆ.

J. Ag. Sp. Gen. and Ord. Floridearum, p. ix. Part of *Delesseriæ* and *Sphærococcoideæ*, *J. Ag. Alg. Medit.* p. 116 and 148. and of *Endl. 3d. Suppl. Harv. Man. Ed. 2, &c.*

DIAGNOSIS. Rosy, purplish, or blood-red sea-weeds, with an inarticulate, cartilaginous or membranaceous, leaf-like or filiform frond, composed either of polygonal or of cylindrical cells. *Conceptacles* with or without a terminal pore. *Spores* roundish or elliptical, formed in moniliform filaments rising from the basal placenta, all the cells of the spore-threads gradually changing into spores. *Tetraspores* variously disposed.

NATURAL CHARACTER. *Root* almost always discoid, rarely branching. *Frond* much diversified in habit, structure, and colour. Most of the North American genera are more or less perfectly leaf-like; the leaf, in the least organised, being an expansion of irregular form, cleft either vertically or laterally, without symmetry, and destitute of central rib or of veins. In others the lower part of the frond is thickened in the centre into a broad, sub-defined midrib, which becomes less evident toward the upper portion of the membrane, and gradually disappears where the laciniae become expanded. In others numerous irregular veins, which are confluent toward the base of the frond, spread out one from another like the rays of a fan and traverse a greater or less portion of the membrane, generally becoming obsolete in its upper divisions; sometimes standing apart and sometimes anastomosing. In others—and these are the most completely organized—the leaf-like body is symmetrical, furnished with a percurrent, filiform midrib, which is a continuation of the stipes or root-stem, and which becomes stem as it is gradually divested of the membraneous border. This takes place with age, and thus old fronds of the same species have often a much branched stem bearing numerous leaves; all which fronds originated in a single leaf whose stripped midrib was converted into stem, and then put forth new frondlets, to undergo a similar metamorphosis. The only North American genus with filiform fronds is *Graci-*

laria, and one of its commoner species (*G. multipartita*) exhibits every stage between a nearly cylindrical, much branched, bush-like frond and a flattened, laciniated membrane.

The internal structure of the frond presents as many varieties as the outward form. Most of the membranaceous fronds are composed of polygonal cellules, not longer than their breadth, those of the surface stratum frequently tabulated. Sometimes the interior cellules are of large size compared to the exterior, and gradually diminish as they approach the surface of the frond, the outer stratum being composed of minute dot-like cells: in other cases all are nearly of equal diameter. In several the axial or medullary region is occupied by cylindrical cells joined end to end into filaments, which are either solitary, or more commonly bundled together or closely compacted into an internal midrib. In others almost the whole internal substance of the frond is composed of a plexus of such filaments, but this structure is rare in the Order, and confined to some genera of the southern hemisphere. As a general rule, an opaque, inarticulate frond, composed of polygonal, tabulated or roundish cellules, is characteristic of these Algæ.

The colour is of various tints, mostly brilliant ones. Some of the finest and purest carmine, crimson and blood-red hues seen among marine plants, are found in this Order. Others are purple-lake, of greater or less brilliancy; and a few, chiefly of the filiform kinds, are dull-red, brownish or whitish, tinted with various pale shades of red, or greenish yellow, the latter colours indicating a weak or blanched growth.

The distinctive character of the Order is found in the structure of the sporiferous-nucleus, which consists of a dense tuft of simple or branched, moniliform spore-threads radiating from a cellular placenta fixed in the base of the cavity of an external conceptacle. The conceptacle is of various forms; bottle-shaped with a prominent orifice, conical, hemispherical or spherical, in the latter cases generally destitute of a pore, and emitting the spores only on the bursting of the pericarp. The walls of this conceptacle are membranous, thick or thin, composed of one or of several strata of cellules. The cavity is generally large, rarely quite filled by the nucleus. The placenta sometimes projects into the cavity so as to fill one-half of the space, and sometimes is but slightly developed. It is always cellular, and generally solid; sometimes, however, hollowed out beneath. The whole surface is densely covered with vertical or radiating simple or dichotomous spore-threads, each consisting of numerous ellipsoidal or roundish cellules which are gradually converted into spores, the terminal cell ripening earlier than the others.

The *tetraspores* are either tripartite or rarely zone-parted, and are either dispersed over the whole frond, or more frequently collected into definite groups or sori, which are sometimes borne in proper leaf-like processes of the frond. They are always sunk among the superficial cells; never collected in *nemathecia*, but sometimes lodged in thickened wart-like prominences rising from the membrane.

Many of the genera of this Order are widely dispersed. The *Delesseriæ* and *Nitophylla* are among the most beautiful of leafy sea-weeds, and are found between the parallels of 30° and 60° north and south of the equator, but are more abundant on the European than the American Atlantic coasts. On the North American

Atlantic coast, indeed, *Nitophyllum* is scarcely more than represented. In South America, especially among the indented shores of Terra del Fuego and the islands and channels near Cape Horn both these genera abound, as they also do in New Zealand and Van Dieman's Land. *Nitophyllum venosum* is one of the largest and most splendid of South African Rhodospirins, its brilliant fronds being sometimes two or three feet in breadth. *Delesseria Leprieurii*, which is found in the Hudson river at Westpoint, sixty miles from the sea, and in the estuaries of several rivers of the Southern States, was first discovered in the Sinnamar river, Cayenne; and has been also found in New Zealand; a singularly sporadic distribution. *Delesseria quercifolia* of the southern hemisphere is scarcely distinguishable from *D. sinuosa* of the northern; the southern *D. crassinervia* chiefly differs from the northern *D. Hypoglossum* by the thickness of its midrib; while *D. ruscifolia* is found in both northern and southern hemispheres. It is curious that *Hymenena* and *Botryoglossum* are found in South Africa and California, the latter genus also at the Falkland Islands. *Grinnellia* is exclusively American, and is one of the most beautiful and characteristic Algæ of the Atlantic coast. *Sphærococcus* is European. Several genera are exclusively from the Southern Ocean, many being Australian. *Gracilaria* is found from the tropics to very high latitudes at either side of the line, and *G. confervoides* and *G. multipartita* are instances of cosmopolitan species.

Of economical species the only ones deserving notice are the *Gracilariæ*, many of which are largely used in India and China, both for food and in the preparation of glues and varnishes. *G. lichenoides* or *Ceylon moss* is a common ingredient in soups and other compound dishes in the East, and is even exported to Europe for similar purposes. It may also be made into jellies and blanc-manges, and is said to be better than *Carrigeen* (*Chondrus crispus*) for all the uses to which that plant is applied. All the *Gracilariæ* readily boil down into a gelatine, and probably are nearly equally valuable.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

TRIBE I. DELESSERIÆ. *Frond* membranaceous, leaf-like; the surface cells tabular, polygonal, of large size. *Spore-threads* radiating in a circle from a depressed, basal placenta. *Tetraspores* contained in definite sori.

* *Fronds* symmetrical, midribbed.

I. GRINNELLIA. *Conceptacles* scattered over the membrane.

II. DELESSERIA. *Conceptacles* formed in the midrib, or in a lateral vein.

* * *Fronds* unsymmetrical, ribless or obsoletely ribbed, or traversed by irregular branching veins.

III. BOTRYOGLOSSUM. *Frond* thickened in the middle, obsoletely midribbed; the rib broad, vanishing towards the end of the lacinia.

IV. HYMENENA. *Fron*d ribless, traversed by numerous, subparallel, anastomosing veins. *Sori* linear, between the veins.

V. NITOPHYLLUM. *Fron*d ribless, either veinless or traversed by obsolete, slender, branching, irregular veins. *Sori* roundish, scattered.

TRIBE 2. SPHÆROCOCCEÆ. *Fron*d flat, compressed, or cylindrical, cartilaginous or coriaceous, the surface cells roundish, very minute. *Placenta* conical, projecting far into the conceptacular cavity. *Tetraspores* mostly dispersed among the surface cells.

* *Tetraspores* oblong, transversely divided (zonate).

VI. CALLIBLEPHARIS. *Fron*d flat, irregularly cleft, fringed with marginal lobes.

* * *Tetraspores* cruciate or triangularly divided.

VII. GRACILARIA. *Fron*d terete, compressed or flat.

VIII. CORALLOPSIS. *Fron*d constricted at regular intervals or nodoso-articulate.

I. GRINNELLIA. (*Nov. Gen.*)

*Fron*d rosy red, leaf-like, delicately membranaceous, areolated, symmetrical, traversed by a slender, percurrent midrib. *Conceptacles* scattered over the surface of the membrane, bottle-shaped, with a prominent orifice : *placenta* basal, somewhat prominent, crowned with a pulvinate tuft of subdichotomous spore-threads, whose terminal cells are earliest ripened. *Spores* elliptic-oblong or roundish. *Tetraspores* tripartite, immersed in scattered, shapeless, cellular warts.

The remarkable plant which I propose as the type of this genus is peculiar to the eastern shores of North America, along which it ranges from Cape Cod to New Jersey. It abounds in Long Island Sound and New York Harbour, where it constitutes one of the most ornamental features of the submarine flora. It was originally described by the elder Agardh as a species of *Delesseria*, a genus which, as then understood, comprehended almost every Alga with a red, membranous, leaf-like frond, and included also within its limits *Plocamium* and *Stenogramme*. From the restricted genus *Delesseria* it is readily known by the position of the conceptacles, which organs in *Delesseria* are invariably placed either on the principal midrib or on one of its lateral branches. To *Nitophyllum* (*Aglaiophyllum*, Mont.)

our plant has also been referred, but, besides the form of the conceptacle, *Grinnellia* differs from *Nitophyllum* in having a perfectly symmetrical frond, furnished with a single percurrent midrib. In some examples this midrib is very slender, but I believe it may always be distinctly traced, at least in the living plant; and when the frond is bifid, as it occasionally is, the midrib regularly bifurcates, one arm pursuing each branch. A further characteristic, showing the difference between this midrib and the irregular veins of *Nitophyllum*, is that in *Grinnellia* the midribs of old fronds become gradually stripped and converted into stems, and are then often proliferous; perfectly formed, ribbed leaflets springing from them. The only other genus of which it is necessary to speak is *Hemineura* (Harv. Ner. Austr. t. 45) but the different nervation and ramification, as well as the position of the conceptacles, afford sufficiently obvious distinctions.

The generic name, GRINNELLIA, is bestowed in honour of HENRY GRINNELL, Esq. of New York, whose noble conduct in promoting the search after the missing Arctic Expedition of SIR JOHN FRANKLIN justly entitles him to the respect and gratitude of every man of science. Doubtless there will be other and more worthy memorials; but yet it seems to me that a beautiful *marine* plant may not unfitly preserve, among the Algologists of America and England, a kindly remembrance of an act of disinterested kindness to wanderers at sea, or let me rather say, a *naval* action to which both Nations may look back with undivided feelings.

1. GRINNELLIA *Americana*.—*Delesseria Americana*, Ag. Sp. Alg. 1, p. 173. J. Ag. Sp. Alg. 2, p. 681. *Aglaiophyllum Americanum*, Mont. in An. Sc. Nat. 3d. Ser. vol. xi. p. 63. *Cryptopleura Americana*, Kütz. Sp. Alg. p. 872. (Tab. XXI. B.)

HAB. On stones and shells, in four or five fathoms. Abundant in Long Island Sound and New York Harbour. (v. v.)

Root scutate. *Frond* densely tufted, leaf-like, from one to two feet in length, and from one to four inches in width at the widest part, lanceolate, tapering to the base, and usually also to the apex, but sometimes very obtuse and sometimes bifid, delicately membranaceous, waved and often curled at the margin, traversed by a slender, slightly wavy, central nerve, which runs through the frond from the base to the apex, gradually becoming more slender upwards, being as thick as hog's bristle in the lower part of the leaf and as fine as human hair towards the tip. The frond usually consists of a single leaf, or of three or four leaves springing a short way above the base of a common stem; but when the membrane of the leaf is destroyed by the waves, as often occurs, the old midrib survives and throws out numerous leaflets, and the frond becomes compound. Such secondary leaflets are usually small and densely crowded. *Fructification* of both kinds abundantly produced and scattered thickly over both surfaces of the membrane. *Conceptacles* resembling in form ancient lacrymatories or the wide glass jars in which sulphuric acid is commonly sold, depressed hemispherical, with a more or less prominent orifice, the neck varying in length on the same plant in different conceptacles. The

walls are thin ; the sporiferous nucleus depressed, not filling the cavity ; the *spores* ellipsoidal, the terminal ones ripening much earlier than the rest. *Tetraspores* tripartite, immersed in fleshy, prominent warts, variously lobed and distorted. *Colour* a brilliant lake-red, quickly becoming orange and soon perishing in fresh water. *Substance* very thin. Surface areolated with large hexagonal cells. In drying, it closely adheres to paper.

Plate XXI. B. *Fig. 1.* GRINNELLIA *Americana*, the *natural* size. *Fig. 2 and 3,* conceptacles of different forms ; *fig. 4,* a conceptacle divided vertically ; *fig. 5,* spore-threads ; *fig. 6,* a wart with tetraspores ; *fig. 7,* the same, divided vertically ; *fig. 8,* a tetraspore ; all more or less *magnified*.

II. DELESSERIA. *Lamour. Grev. ref.*

Frond rosy-red (very rarely purple), leaf-like, lacinate or branched, delicately membranaceous, areolated, symmetrical, traversed by a percurrent midrib. *Conceptacles* sessile on the midrib or on a lateral nerve, globose, without orifice : *placenta* basal, more or less prominent, crowned with a pulvinate tuft of simple or subdichotomous spore-threads whose terminal cells are earliest ripened : *spores* elliptical or roundish. *Tetraspores* tripartite, grouped in definite spots or sori, occupying portions of the frond or of separate leaflets.

With the exception of *D. sanguinea*, Ag. which has a sporiferous nucleus of a very different structure and now forms the genus *Wormskioldia* of J. Agardh, I retain most of the species included in Dr. Greville's restriction of the genus. By Kützinger these are arranged in his genera *Phycodrys* and *Hypoglossum*, groups which I regard as subgenera only. The species are numerous and many of them are widely dispersed. Of the following, *D. tenuifolia* and *D. involvens*, now first described, have been found only on the Florida Keys.

SUB-GENUS 1. PHYCODRYS, Kütz. *Frond pinnatifid or sinuated.*

1. DELESSERIA *sinuosa*, Lamour. ; stem (at length) elongated, branched, beset with oblong or obovate, deeply sinuated or pinnatifid, toothed, penni-nerved leaves ; nerves opposite. *Harv. Phyc. Brit. t. 259. J. Ag. Sp. Alg. 2, p. 691. Phycodrys sinuosa, Kütz. Sp. Alg. p. 874. Fucus sinuosus, Turn. Hist. t. 35. E. Bot. t. 822.*

HAB. Arctic Sea Coast, *Mr. Seeman.* Halifax, *W. H. H.* Boston Bay, *Mr. Emerson, Dr. Durkee, &c.* Newport, *Prof. Bailey, Mr. Olney, &c.*

*Fron*d originating in a single, oblong or obovate, sinuous or deeply pinnatifid leaf, 4—8 inches long and from one to four inches broad, denticulate at the margin, furnished with a strong percurrent midrib, and with opposite, lateral nerves or veins set at an angle with the midrib of about 45°. As the frond grows larger the first formed leaf becomes more deeply lacinated, the laciniae which were at first little more than denticulations lengthening, widening, and becoming again pinnatifid. The membrane of the older parts decays and the denuded midribs are thickened into filiform, imperfectly winged stems and branches, which bear from their sides and apex numerous leaves resembling the original one. Such specimens are often very bushy and dense. The midribs are usually unbranched, but are sometimes forked. The margin of the frond, which in most cases is merely denticulate, is occasionally bordered with slender, simple or fimbriated lacinulae, or fringed with great numbers of minute, accessory frondlets. *Conceptacles* hemispherical, formed from the substance of the midrib or of one of its lateral nerves. *Tetraspores* in sori generally lodged in minute marginal leaflets, rarely dispersed over the membrane in patches following the courses of the lateral nerves. *Substance* membranaceous. *Colour* a purple lake, turning rather brownish in drying. It does not adhere strongly to paper.

A specimen from Dr. Durkee has dispersed tetraspores, and unites this species with the *D. quercifolia* of the Southern Hemisphere, which Kützinger nevertheless places in a different genus.

In deep water the frond often becomes very narrow, with filiform lobes, produced into long tendrils. Some of my Halifax specimens exhibit this character.

2. *DELESSERIA fimbriata*, Delapyl.; "leaves of the ribbed, oppositely veined frond obovate, pinnatifid; laciniae nerveless or having a vanishing nerve, at length separated as proper, linear-oblong, serrated and sinuous leaflets; sori of tetraspores lodged in marginal, acute and acutely toothed fimbriae, sub-geminate; conceptacles sessile on the parenchyma of the frond." *J. Ag. Sp. Alg.* 2, p. 690.

HAB. Newfoundland, *De la Pylaie*; fide *J. Agardh*.

SUB-GENUS 2. *PTERIDIUM*, Kütz. *Fron*d alternately or dichotomously branched, rose-red.

3. *DELESSERIA denticulata*, Mont.; frond alternately decompose or irregularly pinnatifid, costate; branches linear, the primary ones alternate, the secondary often opposite, denticulate or fimbriato-ciliate at the margin; the lamina penninerved with opposite, oblique veinlets; sori linear, at each side of the midrib near the ends of the laciniae. *Mont. in An. Sc. Nat. Ser.* 3. xii. p. 223. *D. alata*, var. *denticulata*, *Mont. l. c.* xi. p. 62.

HAB. Shores of Labrador, *M. Lamare Piquot*, in *Herb. Montagne*. Brandy Pot Island, River de Loup, *Mr. Allom*. (v. s. in *Herb. T. C. D.*)

Of this plant I have as yet seen only small specimens, insufficient to enable me to give as full a description as I could wish. The primary frond is four or five inches or more in length, often a quarter to half an inch broad, linear, membranous, traversed by a strong midrib, which gives off at acute angles alternate branches, one running through each primary lobe, and giving off similar branchlets to the succeeding lobes. The lamina throughout is linear, extending at each side of the midrib like a wing, of variable breadth in different specimens, and closely penninerved with microscopic, articulated, obliquely ascending opposite veinlets, each of which runs out into a marginal tooth or lacinula. These marginal denticulations are sometimes minute, sometimes prolonged into linear, acute, ciliaform processes. *Tetraspores* in linear-sori, extending at each side along the midrib, near the apex of the smaller lacinia. *Axils* acute. *Colour* a purple-rose-red. *Substance* delicately membranaceous.

4. *DELESSERIA alata*, Lamour.; frond irregularly dichotomous or alternately decompound, costate; branches linear, quite entire at the margin; the lamina (sometimes very narrow) penninerved with opposite, oblique veinlets; sori either at the apices of the segments or in proper leaflets. *J. Ag. Sp. Alg.* 2, p. 683. *Harv. Phyc. Brit.* t. 247. *Hypoglossum alatum*, Kütz. *Sp. Alg.* p. 877. *Delesseria angustissima*, Griff.—*Harv. Phyc. Brit.* t. 83. *J. Ag. Sp. Alg.* 2, p. 686. (an extreme form, nearly destitute of membrane.)

HAB. Boston Harbour, *Mrs. Mudge, Dr. Durkee, &c.* (v. v.)

Frond distichous, two to four inches high or more, much branched, linear, from half a line to half an inch broad, alternately decompound, in a manner between dichotomous and pinnate; branches having a cartilaginous midrib winged at each side with a narrow or broadish membrane, which is occasionally obsolete. My American specimens are not in fruit. *Colour* a bright purple-lake. *Substance* membranaceous. In drying, it does not adhere strongly to paper.

I am not aware of this species being found south of Cape Cod. The specimens from Boston are of small size and very narrow, many of them as narrow as *D. angustissima*, Griff., but in all that I have seen there is an evident wing to the midrib.

5. *DELESSERIA serrata*, Post. and Rupr.; "stipes winged, compressed, much branched; branches winged, alternately pinnatifid and bipinnatifid; segments linear, costate, serrated at the margin and incised or pinnated in the upper part; sori punctiform, aggregated at each side of the rib along the whole length of the segments. *Post. and Rupr. Illust.* p. 15. *J. Ag. Sp. Alg.* 2, p. 696. *Hypoglossum serratum*, Kütz. *Sp. Alg.* p. 876.

HAB. Parasitical on the stipes of *Ptilota asplenioides*, at Unalaschka, *Postels and Ruprecht*.

6. *DELESSERIA corymbosa*, J. Ag.; "frond subfiliform, dichotomo-corymbose, the upper segments linear, obtusely acuminate, slightly incurved above the axil, very entire at the margin." *J. Ag. Sp. Alg.* 2, p. 684.

HAB. Greenland, *Vahl*, fide *J. Agardh*.

7. *DELESSERIA rostrata*, J. Ag.; "frond subfiliform, pinnato-dichotomous, the upper segments patent, linear, acuminate, very entire at the margin; conceptacles immersed in the terminal segments, thrice as thick as the excurrent beak-like point of the ramulus and shorter than it; sori of tetraspores elongated below the summit of the segments." *J. Ag. Sp. Alg.* 2, p. 685.

HAB. Greenland, *Fabricius*, *Vahl*, fide *J. Agardh*.

SUB-GENUS 3. *HYPOGLOSSUM*, Kütz. *Frond undivided, oblong or lanceolate, proliferous from the midrib; rose-red.*

8. *DELESSERIA Hypoglossum*, Lamour.; frond linear-lanceolate, tapering at each end, repeatedly proliferous from the opaque, inarticulate midrib with leaflets of similar form; at length much branched. *Harv. Phyc. Brit. t. 2. J. Ag. Sp. Alg.* 2, p. 693. *Hypoglossum Woodwardi*, Kütz. *Sp. Alg.* 875. *Var. β. ovalifolium*, J. Ag. leaves oblong, obtuse or subobtuse, not attenuated. *Var. γ. filiforme*, *Menegh.*; leaves exceedingly narrow, much attenuated at both ends.

HAB. Shores of Carolina and Georgia. Charleston Harbour, the three varieties common, *Prof. Gibbs*, *W. H. H.* Anastasia Island, *Dr. Durkee*. (v. v.)

Frond originating in a simple, lanceolate leaf, which, in the American specimens is seldom more than three or four inches long and a quarter inch wide. This leaf is delicately membranaceous, and has a percurrent, slender, inarticulate midrib formed of numerous, closely packed cylindrical cellules. As the plant develops, the midrib throws out at both surfaces numerous similar leaves which in turn bear others; and thus by the repeated production of new series of leaves from the midrib of the older, the plant at length becomes a leafy ball, very dense with crowded foliage. The margin is entire and generally flat. The membrane is composed of polygonal cells of which those next the midrib are nearly equal-sided hexagons, those next them oblong, and those toward the margin gradually smaller and more cylindrical. *Conceptacles* globose, on the midrib. *Tetraspores* in oblong or linear sori, disposed in pairs at opposite sides of the midrib in the smaller leaves. *Colour* a brilliant carmine-lake. *Substance* delicately membranaceous. The plant quickly becomes orange and decomposes in fresh water, and in drying closely adheres to paper.

In *var. γ.* the leaves are frequently much arched, exceedingly narrow, and tapering to a very slender point. This variety remarkably contrasts with *var. β.* whose

leaflets are as blunt as those of *D. ruscifolia*. Both varieties accompany the ordinary form in Charleston Harbour, the most northerly station hitherto ascertained for *D. Hypoglossum* in America.

9. *DELESSERIA tenuifolia*; frond filmy, pale rose-red, broadly linear, obtuse, flat, repeatedly proliferous from the capillary, articulated midrib with leaflets of similar form; at length much branched, fastigate. (TAB. XXII. B.)

HAB. At Key West, Feb. 1850, *W. H. H.* (v. v.)

Frond originating in a linear, obtuse, perfectly flat leaf, one or two inches long and about two lines in breadth, of extreme tenuity, and furnished with a percurrent, articulated midrib composed of a triple row of cells, of which the central cell is cylindrical and more deeply coloured, the border cells half-hexagonal; the three cells taken together forming a hexagonal areole or articulation of the midrib. This primary leaf emits others from its midrib, and the process is repeated till there results a much branched, fastigate, globose frond, whose lower branches (the denuded midribs of the primary leaves) are thickened to the diameter of a hog's bristle. I have not seen *conceptacles*. *Tetraspores* occur in very small sori placed one at each side of the midrib near the tips of the young leaves. The substance of the membrane is exceedingly thin and semi-transparent. The cellules toward the midrib are large and polygonal, not regularly hexagonal, but nearly so; those toward the margin oblong or cylindrical, disposed in lines at an angle of 45° with the midrib. *Colour* very pale. In drying, it adheres most closely to paper.

Thin and delicate as are the leaves of *D. Hypoglossum*, those of the present species are much more so, and, when dry, appear as a mere glossy film on the surface of the paper. Under the microscope, it is easily known from *D. Hypoglossum* by the structure of the midrib, and the disposition of the cellules of the membrane, while its pale colour and extreme tenuity sufficiently mark it to the naked eye. In the form of the leaf it resembles *D. ruscifolia*, but in other respects abundantly differs from that strong-growing species.

Plate XXII. B. *Fig. 1*, *DELESSERIA tenuifolia*, the *natural* size. *Fig. 2*, some leaves, with sori in their apices; *fig. 3*. apex of a leaf enlarged to show the structure of the membrane; *fig. 4*, a tetraspore;—all *magnified*.

10. *DELESSERIA involvens*; frond filmy, pale rose-red, linear-lanceolate, attenuate, having the apex strongly involute, bordered with oblique bullate undulations repeatedly proliferous from the articulated midrib with leaflets of similar form; at length much branched and fastigate. (TAB. XXII. A.)

HAB. At Key West, Feb. 1850, *W. H. H.*, *Dr. Blodgett*. (v. v.)

The mode of composition of the frond is the same as in the last species; a pri-
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mary leaf, by repeated proliferous development, resulting in a much branched, subdichotomously or secundly divided, globose, fastigate frond, two or three inches in diameter. Each individual leaf is from half an inch to an inch long and about half a line broad, narrow linear-lanceolate, obtuse at the base, much attenuate at the extremity, which is invariably, on very numerous specimens which I have examined, strongly rolled inwards, and cannot be unrolled without difficulty, immediately rolling up again when released. The margin is quite entire; within it is a wide border, occupying more than a third part of the breadth of the leaf, composed of narrow cylindrical cells disposed in obliquely ascending lines at an angle of about 45° with the midrib; and throughout this border the membrane is raised up in oblong undulations having a common direction with the lines of cells, and appearing more strongly coloured than the surrounding parts. The portion of the lamina between the border and midrib is composed of hexagonal cells of which the innermost are largest. The midrib is of the same structure as in *D. tenuifolia*, but formed of larger cellules. In old specimens it becomes, when denuded, thickened into the setaceous stem and branches of the compound frond. *Conceptacles* very convex, more than hemispherical, borne on the midrib. *Tetraspores* in small irregular sori, one at each side of the midrib in the smaller leaves. *Colour* a pale rosy red. *Substance* extremely thin and delicate. In drying, it adheres most closely to paper.

Plate XXII. A. *Fig. 1.* *DELESSERIA involvens*, the natural size. *Fig. 2.* Some leaves, growing proliferously; *fig. 3.* a leaf, highly magnified to show the structure; *fig. 4.* *tetraspores* lying among the surface cells; all more or less highly magnified.

SUB-GENUS 4. CALOGLOSSA, Harv.; *Frond* dichotomous, articulato-constricted, rooting at the forks, livid purple.

11. *DELESSERIA Leprieurii*, Mont.; frond livid-purple, linear, dichotomous, either rooting or proliferous at the forks; the space between each furcation linear-lanceolate; the ultimate divisions attenuate, bifid at the apex; midrib articulated, three-tubed; conceptacles nearly spherical, on the midrib; tetraspores in lines obliquely drawn from the midrib to the margin near the apices of the branches. *Mont. An. Sc. Nat. 2nd ser. vol. xiii. p. 196, t. 5, fig. 1. J. Ag. Sp. Alg. 2, p. 682. Hypoglossum Leprieurii, Kütz. Sp. Alg. p. 875. (TAB. XXII. C.)*

HAB. In tidal rivers, growing on stones, woodwork, or on phænogamous water plants, &c. Discovered in North America by *Prof. Bailey* in the Hudson at West Point, and found more recently in the Ashley and Cooper Rivers, S. Carolina, and in several rivers of Georgia and Florida. *Apalachicola, Capt. Pike. (106). (v. v.)*

Frond one to two inches high, from half a line to a line in diameter, many times regularly dichotomous, constricted at the forks, and traversed by a slender midrib. At the point where the midrib bifurcates, there is generally formed a small rootlet or process by which the plant attaches itself when young. Afterwards, when the

divisions are more erect, these expand into frondlets of similar shape to the original, being at first simple, then forked, and at length repeatedly dichotomous. The midrib is formed of a triple row of cylindrical cells of equal length; the membrane, of hexagonal cells set in lines extending obliquely from the midrib to the margin, and gradually of smaller size as they recede from the midrib. The *conceptacles* are very rare, and are formed at the expense of the rootlike process at the furcations. They contain within a thin wall strings of conoidal spores borne on a large cellular, basal placenta. *Tetraspores* are more frequently found, and occupy the summits of the leaves, where they are set in obliquely ascending lines. *Colour* a livid purple, fading to green. *Substance* membranous, not very closely adhering to paper in drying.

A very distinct and curious little species of a colour most unusual in this genus, recalling forcibly the colour of the *Bostrychia*, plants found in similar situations. I have only seen conceptacles in one or two specimens from Cooper River, but tetraspores are common in Westpoint individuals. These latter are more slender and much more attenuate at the apices than those from Charleston; a circumstance to be anticipated not merely from the difference of climate, but chiefly from the large admixture of fresh water in the stream of the Hudson at sixty miles above its mouth.

Plate XXII. C. *Fig. 1.* *DELESSERIA Leprieurii*, the *natural* size. *Fig. 2.* a branch to show ramifications and rootlets; *fig. 3.* apex of a branchlet, to show the structure; *fig. 4.* portion with a *conceptacle* formed; *fig. 5.* vertical section of a conceptacle; *fig. 6.* spores; all more or less highly *magnified*.

BOTRYOGLOSSUM. *Kütz.*

Frond purplish red, with an opaque, cartilaginous stem expanding upwards into an irregularly cleft, coriaceous-membranaceous, areolated lamina, traversed in the lower part by an obsolete, vanishing midrib. *Conceptacles* scattered, sub-hemispherical, with a prominent orifice; placenta basal, crowned with a pulvinate tuft of moniliform spore-threads, whose terminal cells are earliest ripened. *Tetraspores* tri-partite, grouped in definite spots or sori, occupying portions of the frond or lodged in accessory leaflets.

Under this genus I include *Neuroglossum*, Kütz. which merely differs from *Botryoglossum* of the same author in having its tetraspores lodged in intra-marginal sori instead of in foliaceous marginal processes, a character which I consider of such minor importance that I am not sure that it is even of specific value, much less generic. In *Delesseria sinuosa*, *Nitophyllum laceratum*, and even in our *Botryoglossum*

platycarpum both positions of tetraspores occur. Indeed I am by no means convinced that Kützing's *Neuroglossum Binderianum* is specifically distinct from *B. platycarpum*.*

Kützing has, as I think unadvisedly, referred *Jeannerettia lobata*, Hook. and Harv. (Ner. Austr. t. 4.) to this place, overlooking the nature of its stichidia, which, in my opinion, clearly indicate an affinity with *Rhodomelaceæ*. However, as the conceptacular fruit is as yet unknown, it may be premature to regard the question decided.

1. BOTRYOGLOSSUM *platycarpum*, Kütz. ; sori of tetraspores (generally) lodged in small leafy processes, which either fringe the margin or are dispersed over the surface. Kütz. *Sp. Alg.* p. 881. *J. Ag. Sp. Alg.* 2, p. 676. *Fucus platycarpus*, Turn. *Hist.* t. 144. *Delesseria platycarpa*, Ag. *Syst.* p. 252. (TAB. XXI. A.)

HAB. Monterey, California, Mr. Douglas ! Dr. Coulter ! Dr. Sinclair ! Capt. Wilkes ! (v. v.)

Root a large conical disc, throwing out lateral branches. *Fronds* twelve inches long or more, irregularly di-trichotomous or palmate-parted, divided nearly to the base into numerous linear-cuneate laciniaë, which are either simple, or again similarly divided. The lower part of the frond and of its divisions is furnished with a very broad, flat midrib, which spreads over the greater part of the disc. This midrib is cartilaginous and very thick below, but becomes thinner and less defined above, and at length disappears in the upper and wider portions of the cuneate laciniaë. In young fronds the margins of the laciniaë are either deeply crenate or obtusely pinnatifid, the lobes being sometimes deep, sometimes shallow, always very obtuse with bluntish or rounded interspaces. In some specimens the lacinia is merely repand. In old plants the margin is frequently worn away and much jagged, the membrane being reduced to a narrow wing-like border to the broad midrib. In fertile specimens the eroded margin produces a multitude of minute, leaf-like, roundish or lobed processes half a line to a line in breadth, sometimes scattered, but more frequently densely crowded and forming a thick fringe to the segment. In these processes are sometimes found tetraspores immersed in thickened central discs ; and sometimes conceptacles. The tetrasporic fruit is most common. A thin slice of the frond shows several rows of muriform cells, of which the central row is of larger size. The outer row alone contains coloured matter. When the membrane is viewed vertically, the surface appears areolated with hexagonal cells, among which may be traced faint indications of internal, branching veins. *Colour* a dark purplish red, becoming browner in drying. *Substance* cartilaginous and thick. It scarcely adheres to paper in drying.

The tetraspores are by no means confined to the marginal leaflets. In some of

* Since this was prepared for the press, I observe that Professor J. Agardh unhesitatingly unites these plants. *Sp. Alg.* 2, p. 676.

Douglas' and Coulter's specimens, where the margin is uninjured, they are congregated in large, dense, linear intra-marginal sori, extending along the sides of the laciniaë. Toward the apices the sori are linear, branching and anastomosing, as in *Hymenena*; and all three characters of sorus, the simply intermarginal, the branching and anastomosing, and that placed in the extramarginal leaflet, may sometimes be found on the same root! The existence of such specimens considerably weakens the claims of *B. Binderianum* to specific distinction.

Plate XXI. A. *Fig. 1.* BOTRYOGLOSSUM *platycarpum*, the natural size. *Fig. 2.* marginal leaflet, with sorus; *fig. 3.* a tetraspore; *fig. 4.* portion of the areolated surface; *fig. 5.* section through the frond; the latter figures *magnified*.

IV. HYMENENA. *Grev.*

Frond rosy red, expanded, irregularly laciniated, unsymmetrical, membranaceous, areolated, without midrib, but everywhere traversed with numerous prominent, anastomosing, subparallel nerves. *Conceptacles* sessile on the nerves, depressed in the centre (umbilicate), with an orifice; walls very thick; *placenta* basal, slightly prominent, crowned with a depressed tuft of dichotomous spore-threads whose terminal cells are earliest ripened. *Tetraspores* tripartite, in long linear sori lodged in the spaces between the nerves, or in marginal leaflets.

This genus, which is perhaps too closely related to the preceding, chiefly differs in the absence of midrib, and in the numerous anastomosing nerves which supply its place. It is distinguished from *Nitophyllum* by the form of the conceptacle and the thickened substance. The linear disposition of tetraspores occurs in the three genera.

1. *HYMENENA fissa*, *Grev.*; frond palmate, the laciniaë linear-cuneate, undulate, obtuse, erect, very entire at the margin. *Harv. Ner. Austr. p. 118, t. 44.* *Kütz. Sp. Alg. p. 873.* *J. Ag. Sp. Alg. 2, p. 674.* *Fucus venosus, Turn. Hist. t. 138.*

HAB. Monterey, California, *Capt. Beechey*; *Capt. Wilkes.* (v. v.)

Root branching. *Fronds* six to twelve inches high, palmate, or irregularly dichotomous, broadly cuneate in outline. *Laciniaë* linear-oblong, simple or lobed, undulate, with an entire margin. Every part of the frond is traversed by closely placed, longitudinal, anastomosing prominent nerves, on which the *conceptacles* are formed, and between which the *tetraspores* are scattered in long lax sori. The

colour when recent is a brilliant purplish lake, reflecting prismatic hues, especially when viewed through water. The *substance* is rather rigid, containing much saline matter and mannite. In drying, it does not adhere to paper.

I do not possess American specimens of this plant, and transfer this description from *Ner. Austr.* p. 118. An outline drawing of Capt. Wilkes's plant sent to me by Prof. Bailey seems to accord well with my Cape of Good Hope specimens, and I formerly examined one of Capt. Beechey's which appeared also similar.

2. *HYMENENA fimbriata*, Post. and Rupr.; frond palmate or multifid, the segments cuneate, deeply lobed, round-topped, traversed by numerous dichotomous nerves which coalesce into a broad compound nerve or imperfect midrib toward the base; the margin of fertile specimens fimbriate with small, roundish leaflets. *Post. and Rupr. Illustr.* p. 15, t. 38. *Kütz. Sp. Alg.* p. 873. *J. Ag. Sp. Alg.* 2, p. 674. *Hymenena fissa*, β . *marginata*, Harv. in *Bot. Beech. Voy.* p. 407.

HAB. St. Francisco, *Dr. Sinclair*. Golden Gate, *Capt. Pike* (21). Norfolk Bay, *Postells and Ruprecht*. (v. s. in Herb. T. C. D.)

Frond 12—14 inches long, with a linear-cuneate stipe three to four inches long, nearly filled in its lower part with a broad cartilaginous midrib. As the frond gradually widens upwards, the midrib branches into numerous strongly elevated nerves which divide more and more, distributing themselves among the laciniae of the palmate or multifid membrane. Each segment is broadly linear, half an inch to an inch wide, cuneate, rounded at the top, two thirds or more of its surface occupied by the dichotomously branched, longitudinal nerves, which in some specimens are very strongly elevated, with deep furrows between them, in others less evident and even somewhat obliterated. The margin in young specimens is flat and smooth, in older ones fimbriate with minute roundish processes, which bear the fructification. *Tetraspores* in the thickened marginal lobes, precisely as in *Botryoglossum*. *Structure*, of several rows of quadrate, muriform cells. *Colour* a dark purple-lake. *Substance* rigid. It does not adhere to paper.

This plant has so much in common with *Botryoglossum platycarpum*, that it is hardly natural to place them in different genera.

V. NITOPHYLLUM. *Grev.*

Frond rosy-red or purplish, expanded, irregularly laciniated, unsymmetrical, delicately membranaceous, arcolated, without midrib, either altogether destitute of nerves or having towards the base a few irregular, branching, vanishing nerves. *Conceptacles* sessile, scattered, globose, without orifice; *placenta* basal, crowned with

a pulvinate tuft of simple or dichotomous spore-threads whose terminal cells are earliest ripened : spores elliptical or roundish. *Tetraspores* tripartite, grouped in definite spots or sori, variously dispersed over the frond.

This genus is nearly related to *Delesseria*, from which it is only to be distinguished by its unsymmetrical frond destitute of a single percurrent midrib. This character will generally be found sufficient readily to distinguish these groups, but some species of the southern hemisphere exhibit intermediate stages ; as *Delesseria dichotoma* and *Nitophyllum multinerve* which sometimes approach each other inconveniently near.

A considerable number of species have been described, which Kützing divides into three genera, *Aglaiophyllum*, *Schizoglossum*, and *Cryptopleura*, distinguished by some differences in the structure of the frond. *Aglaiophyllum* is limited to those species which are altogether nerveless, and have a membrane composed of a single stratum of large cellules: *Cryptopleura* to those in which nerves are more or less obvious, with a similarly constructed membrane : and *Schizoglossum* to such nerveless species as have a membrane composed of more than one stratum of cellules. I do not adopt these genera, because I find the characters untenable. The more or less nervated frond varies even in the same species ; *Schizoglossum Gmelini*, Kütz. for instance, which ought, by generic character, to be nerveless, is frequently abundantly supplied with nerves, much more abundantly than *Cryptopleura Bonnemaisoni* and *C. Crozieri*. The character founded on compound structure is equally nugatory, for *Cryptopleura lacerata*, which is, moreover, the *type* of the genus so called, has a frond constructed of more than one row of cellules, contrary to the generic character. There is, indeed, a most close affinity in structure between *S. Gmelini* and *C. lacerata*, and they cannot be separated generically without violence.

With respect to nomenclature, I prefer retaining the name *Nitophyllum*, under which this genus was first defined, although it may not be constructed on classical principles, to adopting the modern, more classical, but less euphonious, and as I think unnecessary *Aglaiophyllum* of my friend Dr. Montagne. The change of long established names, except in cases of clear necessity, is very objectionable ; and if all names in natural history were to be rejected that are not founded according to strictly classical rules, a large number of new synonyms would soon be added to the copious list already a burden to the science.

One of the more distinctive features of the marine flora of the Atlantic coast of America as compared with that of Europe is, as has been already noticed in our introduction (Part i, p. 24), then early total absence of species of *Nitophyllum*, a genus which abounds on the European coasts, where many kinds are dispersed from the shores of Scotland to those of Spain, and in some places in such profusion that they give the chief character to the vegetation, at certain depths. In contrast to this I can only as yet claim, for the North American seaboard, a few scraps, almost too imperfect for determination. Very different is the case on the shores of South America, beyond the tropic, where the genus flourishes in many fine species, as also

on the South African continent, and along the southern shores of Australia and New Zealand.

1. *NITOPHYLLUM punctatum*. Var. *ocellatum*, Grev. ; frond linear, many times dichotomous, fastigiate, the axils rounded and apices blunt ; sori scattered over the lower segments of the frond. *Harv. Phyc. Brit. t.* 203, *fig.* 1. *J. Ag. Sp. Alg.* 2, p. 659. *Nitophyllum ocellatum*, Grev. *Alg. Brit.*—*Grev. Scot. Crypt. t.* 347. *Aglaio-phyllum ocellatum*, Mont.—*Kütz. Sp. Alg.* p. 867.

HAB. At Key West, *W. H. H.* (39). Smithville, N. Carolina (?), *Mr. C. Congdon.* (v. v.)

The Key West specimens are about two inches high, exceedingly thin and filmy, divided nearly to the base into repeatedly dichotomous laciniae, which are about a quarter inch wide. The margin is flat or slightly undulated. The sori are of large size, nearly orbicular, irregularly scattered on the laciniae. *Colour* a delicate rosy red. *Substance* very soft and flaccid. It adheres most closely to paper in drying.

The specimens examined are very similar to a specimen from Catania, Sicily, preserved in Herb. T.C.D. They are smaller and more delicate in substance than the ordinary British form of this variety ; but in so variable a species no importance attaches to such minor differences.

Mr. Congdon's specimens from the mouth of the Wilmington river are very imperfect and destitute of fructification, but, so far as I can judge, belong to the ordinary form of *N. punctatum*. It is to be hoped that some southern collector may ascertain the fact.

2. *Nitophyllum laceratum*, Grev. ; frond sessile or shortly stipitate, dichotomous, traversed by numerous slender, branching, and anastomosing nerves ; segments linear, variously cleft and lobed, waved at the margin, obtuse ; spots of tetraspores oblong, either intra-marginal or borne on distinct leafy processes of the margin. *Harv. Phyc. Brit. t.* 267. *J. Ag. Sp. Alg.* 2, p. 657. *Cryptopleura lacerata*, *Kütz. Sp. Alg.* p. 870. *Fucus laceratus*, *Turn. Hist. t.* 68. *E. Bot. t.* 1067.

HAB. Newfoundland, *De la Pylaie*, fide *J. Agardh*. Golden Gate, California, *Capt. Pike* (47). (v. v.)

Frond (in the Californian specimens examined) six to eight inches long, cleft nearly to the base into numerous linear segments half an inch wide below, branched alternately or subpalmatifid above, each ultimate lacinia a quarter inch wide, linear oblong, obtuse, erect, the axils rounded. The whole substance of these specimens is traversed with slender, branching, immersed veins, very visible when the frond is examined with a pocket lens. *Tetraspores* either in linear, intra-marginal, longitudinal sori, or in little, roundish marginal leaflets. *Colour* a livid

purple-red. *Substance* rigidly membranaceous. In drying, it imperfectly adheres to paper.

The specimen examined accords very well with some of those from the west coast of Ireland where this species abounds, and where it exhibits many variations in breadth and ramification. It is easily recognised from all its congeners except *N. Gmelini* by the position of the sori. We have not perhaps sufficient data yet to determine whether *Hymenena fimbriata* be anything more than an extravagant variety of this plant, as I have sometimes supposed.

VI. CALLIBLEPHARIS. Kütz.

Frond flat, cartilagineo-membranaceous, dichotomo-pinnate, often margined with wing-like segments or ciliate, formed of two strata of cells; the medullary cells roundish-angular, longitudinal, of large size, in several rows; the cortical minute, coloured, in one or two rows. *Conceptacles* sessile on the marginal processes, with a thick pericarp, containing on an elevated basal placenta a dense tuft of fastigiate, moniliform spore-threads forming ellipsoid spores from their upper articulations. *Tetraspores* oblong, zonate, lodged in the peripheric cells of the frond (dispersed), or of the marginal processes.

Separated by Kützing from *Rhodymenia*, on account of the very dissimilar structure of the conceptacular nucleus, and the zonate division of the tetraspores. This last character distinguishes it from *Gracilaria*, from which also it differs by a peculiar habit. The species are of a very deep and brilliant red while growing, but become darker, sometimes almost black, in drying. Their substance is thicker than that of most of the membranous plants of the Order. They are natives of the Northern and Southern Oceans.

1. *CALLIBLEPHARIS ciliata*, Kütz.; root branching; frond shortly stipitate, thick, subcartilaginous, dull-purplish red, lanceolate or forked, irregularly pinnated with lanceolate or bifid segments, which are attenuated at the base; the margin, and often the disc, more or less furnished with subulate processes in which the conceptacles are lodged; tetraspores collected in cloud-like patches, dispersed over the lamina. *Kütz. Sp. Alg.* p. 755. *J. Ag. Sp. Alg.* 2, p. 619. *Rhodymenia ciliata*, *Grev. Harv. Phyc. Brit.* t. 127. *Fucus ciliatus*, *Turn. Hist.* t. 70, fig. a—e. *E. Bot.* t. 1069. Var. *β. cirrhata*; frond very narrow, dichotomous, the apices cirriform, repeatedly forked.

HAB. Boston Bay, *W. H. H.* Var. *β.* dredged in Halifax Harbour, *W. H. H.* (v. v.)

My American specimens of this plant are neither numerous nor quite satisfactory. One from Boston Bay is not unlike some of the smaller forms of the species as known in Europe. It is about four inches long, partly dichotomous, partly pinnated with lateral, simple laciniae, the margin closely fringed with slender, sub-filiform, simple or slightly branched processes from a quarter to half an inch in length. The colour is dark red, inclining to purple; and though it has perhaps more the technical characters of *C. jubata*, its aspect and substance are those of *C. ciliata*.

The Halifax specimens were dredged in deep water, to which circumstance I attribute their peculiarities. They are but two or three inches in height; one of them is half an inch wide at the widest part, but the usual breadth is from one to two lines or less. The frond is cuneate at base, twice or thrice forked, the apices of the last divisions drawn out into filiform points which are repeatedly forked toward the summit. The margin is fringed with slender lobes, from one to two lines to upwards of an inch in length, in the latter case often dichotomous. Can these be *Rhodophyllis veprecula*, J. Ag.?

VII. GRACILARIA. Grev. J. Ag. ref.

Frond either filiform, compressed, or flat, narrow, carnosocartilaginous, dichotomous or irregularly decompound, composed of two strata of cells; the inner stratum of large, roundish-angular longitudinal cells, more or less filled with granular matter; the outer of minute, coloured cellules in vertical lines. *Conceptacles* sessile on the branches, hemispherical or conical, with a thick pericarp at length opening by a terminal pore, containing, on an elevated basal placenta, densely tufted, dichotomous, fastigiate, moniliform spore-threads radiating to every side; *spores* evolved in the upper articulations. *Tetraspores* oblong, cruciate, dispersed among the surface cellules of the branches and ramuli.

This genus, originally proposed by Dr. Greville in his *Algæ Britannicæ*, has been amended by Prof. J. Agardh by the rejection of such species as do not accord with the above characters. It is the same as the *Plocaria* of Endlicher, and, to a great extent, as the first section of Kützing's genus *Sphærococcus*. The name *Plocaria candida* was given by Nees von Esenbeck to the Ceylon moss of commerce (*Gracilaria lichenoides*?), and has been extended to the Grevillio-Agardhian genus by Endlicher on the plea that it had the priority in order of publication. But I agree with Professor Agardh in regarding the mutation of an established generic name as being in this instance uncalled for, inasmuch as the name *Plocaria* (which has very little the priority over *Gracilaria*) was given in ignorance of the natural affinities of the plant so-called, Nees believing it to be a lichen; nor is it very

certain whether the author intended to include in his description one or many species.

The type of this genus is the *Fucus confervoides*, Lin.; a widely dispersed plant, found from the tropics to a high latitude in both hemispheres. *G. multipartita* has also very considerable geographic range. Many of the species, perhaps all, may be reduced by boiling to a tasteless gelatine, which when properly seasoned is palatable and considered wholesome. Some of the tropical species, particularly *G. lichenoides*, yield a very tenacious jelly.

1. *GRACILARIA cervicornis*, J. Ag.; membranaceo-cartilaginous, flattish, pinnately decomposed; pinnæ linear, dentate, the ultimate ones often filiform, teeth very acute; conceptacles hemispherical, apiculate, on the disc of the upper lacinia near the margin. *J. Ag. Sp. Alg.* 2, p. 604. *Sphærococcus cervicornis*, Kütz. *Sp. Alg.* p. 775. *Rhodymenia cervicornis*, Montagne. *Voy. Bonite*, p. 108. *Fucus cervicornis*, Turn. *Hist.* t. 121.

HAB. Gulf of Mexico, *J. Agardh*. (v. s. in Herb. T. C. D.)

Frond six or eight inches long, pinnately much branched, the upper branches more or less dichotomous. Main rachides flat, one or two lines broad, linear; branches not half that breadth, the upper ones very narrow and subterete. Marginal teeth very acute. Colour in the dry state dull brownish, with a purple tinge. Substance rigid.

Of this plant I possess only South American specimens.

2. *GRACILARIA multipartita*, J. Ag.; frond compressed or flat, dull purplish-red, deeply cleft vertically in an irregularly dichotomous or palmate manner; lacinia linear-wedge-shaped, acute; conceptacles conical, very prominent, numerous, scattered. *J. Ag. Sp. Alg.* 2, p. 600. *Harv. Phyc. Brit.* t. 15. *Sphærococcus polycarpus*, Grev. *Crypt. Scot.* t. 352. *Fucus granateus*, Turn. *Hist.* t. 215. Var. *β. angustissima*; frond exceedingly narrow, almost filiform below, compressed, irregularly dichotomous, the apices frequently palmatifid.

HAB. Pacific Coast, California, *Douglas* ! *Capt. Pike* ! Massachusetts Bay, *Capt. Pike* ! Long Island Sound and New York Harbour, *Prof. Bailey* ! *Mr. Hooper* ! *W. H. H.*, &c. Charleston Harbour, *Prof. Gibbes* ! *W. H. H.*, &c. *β.* at Providence, Rhode Island, *Prof. Bailey* ! *Mr. S. T. Olney* ! Longbranch, New Jersey, *Miss Morris*. Charleston, *W. H. H.* (v. v.)

Frond six to twelve inches long, extremely variable in breadth and in its ramification. Stem short, at first sub-filiform, compressed, soon expanding into the cuneate base of a flat, multifid frond, somewhat flabelliform in outline, and more or less deeply cleft vertically into numerous lacinia, varying in breadth from quar-

ter to half an inch or more. These laciniae are sometimes strap-shaped and nearly simple, or having at one side a few lateral lobes; sometimes they are secundly or alternately multifid; sometimes nearly regularly dichotomous, sometimes palmatifid; and frequently the summits of long, nearly simple lobes are shortly palmate. *Apices* acute, somewhat attenuate, often jagged or irregularly cleft. *Arils* rounded but not very wide. The colour is a dark brownish purple, changing to greenish on exposure. The substance is thickish, cartilaginous, and rather brittle. *Conceptacles* prominent, and generally very abundant on the branches of fertile specimens. In drying, it adheres to paper.

Var. β . which Prof. Bailey finds growing in vast quantities on a sandy bottom, is for the most part so exceedingly slender that it may readily be taken for a distinct species, or even confounded with *G. confervoides*. I have however distinctly traced the connection between the narrowest form and the ordinary one, and this through an extensive series of specimens collected from various localities. Even among Prof. Bailey's specimens from Providence there is considerable variation in breadth and flatness.

3. *GRACILARIA compressa*, Grev.; frond succulent, brittle, somewhat compressed, alternately or subdichotomously branched; branches long and mostly simple, tapering to a fine point; conceptacles ovate or subglobose, sessile, prominent, numerous, scattered. *J. Ag. Sp. Alg.* 2, p. 593. *Harv. Phyc. Brit.* t. 205. *Sphærococcus lichenoides*, Grev. *Crypt. Scot.* t. 341.

HAB. Gulf of Mexico, at Vera Cruz, *Kützling, Sp. Alg.* p. 774. (v. s. in Herb. T.C.D.)

I have not seen any American specimen of this plant. British ones are 6—12 inches long, the branches 1—2 lines in diameter, succulent and brittle, of a beautiful transparent lake-red. Some varieties of *Solieria chordalis* have externally a considerable resemblance to this, but the fructification and the internal structure of the frond are widely different.

4. *GRACILARIA confervoides*, Grev.; frond cartilaginous, cylindrical, filiform, irregularly (often very slightly) branched; branches long, subsimple, erect, attenuate; ramuli few, tapering at each end; conceptacles sessile, scattered, roundish or conical. *J. Ag. Sp. Alg.* 2, p. 587. *Harv. Phyc. Brit.* t. 65. *Fucus confervoides*, L. *Turn. Hist.* t. 84. *E. Bot.* t. 1668. Var. β . *longissimus*, frond very long, nearly simple, naked or with a few filiform lateral branches.

HAB. Key West, *Mr. Binney, Dr. Blodgett* (46). *Apalachicola, Capt. Pike* (36). Var. β . dredged in Charleston Harbour, *W. H. H.* (v. v.)

The ordinary specimens of this variable species are six or eight inches long, as

thick as sparrow's quill, gradually attenuate upwards, more or less branching, sometimes very much branched, irregularly decompound, the branches alternately cleft or subdichotomous. The lesser divisions are mostly distichous, either alternate or secund, and are commonly virgate with a few short lateral ramuli, always attenuate to the acute apex. Axils rounded. *Conceptacles* scattered over all the branches, prominent, as large as rape-seed. *Colour* when growing in deep water a dark, dull purple or brownish, much paler in shallow places, and fading on exposure to a waxy white. *Substance* rigid, cartilaginous.

Var. β . is often six feet long and quite simple, or with a few short lateral ramuli. Its peculiarities appear to result from its place of growth, and intermediate forms connect it with the ordinary much branched varieties.

5. *GRACILARIA armata*, J. Ag.; frond robust, cartilaginous, subcompressed, divaricately much branched, distichous; larger branches forked, their divisions multifid; lesser branches and the subulate, curved ramuli generally secund; axils very obtuse; conceptacles ellipsoidal, depressed, scattered on the larger branches. *J. Ag. Sp. Alg.* 2, p. 591. *Sphærococcus armatus*, Kütz. *Sp. Alg.* p. 774.

HAB. Key West, *Dr. Wurdeman*, W. H. H. (49), *Dr. Blodgett* (58 and 68), *Prof. Tuomey* (15). (v. v.)

*Fronde*s densely tufted, six to eight inches long, as thick as crow's quill below, attenuated upwards, excessively, but very irregularly branched. All parts of the ramification are much divaricated. The main branches either arise several together, from nearly the same point of a short, erect stem, or they divide in an irregularly dichotomous manner, one arm of the fork being frequently suppressed. In this way the branch becomes zig-zag flexuous with secund divisions. The tendency to secund ramification is greater in the minor divisions, almost all the smaller upper branches being secund and set with several linear-subulate, secund, incurved or arching ramuli, the lowermost of which are an inch long, the rest gradually shorter. *Colour* varying from a dark brownish purple to dirty white. *Substance* cartilaginous, but softer than in *G. confervoides*. *Conceptacles* scattered over the branches, not very prominent, longer than their breadth, obtusely conical, with thick walls. In drying, the frond shrinks much, and imperfectly adheres to paper.

6. *GRACILARIA divaricata*; frond cartilagineo-membranaceous, succulent, subterete, collapsing and plano-compressed when dry, divaricately much branched, sub-distichous; branches irregularly dichotomous, zig-zag or secund, very patent, attenuated to a fine point, copiously furnished with lateral, horizontal, simple or forked ramuli, apices all very acute; fr——?

Key West, *Prof. Tuomey*. (No. 13.) (v. s. in Herb. T.C.D.)

A single specimen only seen by me. *Fronde* about four inches long, a line or rather more in diameter at the base, much attenuated upwards, very much branched in a very irregular manner, between dichotomous and secundate, the main divisions frequently secund, and then dichotomously multifid. Principal branches and their divisions distichous. *Ramuli* irregularly inserted, nearly at right angles with the branches, two or three lines long, simple or forked, very acute, the bifid ends divaricating. *Colour* a purplish red, fading to white. *Substance* much more tender than in *G. confervoides*. Fruit unknown.

7. *GRACILARIA Poitei*, Lam. ; frond terete, very thick and robust, cartilagineo-corneous, dichotomously decompound, fastigiate, densely branched ; branches erecto-patent, with rounded angles, dichotomo-multifid or furnished with lateral short ramuli, the apices very obtuse, rounded or truncate or sometimes incrassated and distorted ; conceptacles obtusely conical, depressed, scattered on the larger branches. *J. Ag. Sp. Alg.* 2, p. 596. *Fucus Poitei*, *Lam. diss.* p. 63, t. XXXI. fig. 2, 3.

Key West, rare, *W. H. H.* (48). (v. v.)

Fronde (in my specimens) about three or four inches high, varying in diameter from the thickness of a pigeon's quill to that of a goose quill, shrinking very much in drying, somewhat flabelliform in outline, rising at first with an undivided, erect stipe, then forking and afterwards repeatedly irregularly divided ; the branches opposite, alternate or secund, fastigiate or nearly so, dichotomo-multifid, of nearly equal diameter throughout. *Axils* rounded. Lateral ramuli few, chiefly near the ends of the branches. *Apices* very obtuse, rounded or truncate, sometimes much thickened, and occasionally hollowed out into cups twice or thrice as wide as the branch. *Conceptacles* plentiful, obtusely conical, with a wide mouth opening by a largish pore. *Colour* a livid purple, fading to greenish white. *Substance* carnosocartilaginous when recent, rather horny when dry. It does not adhere to paper in drying.

My specimens are more robust than those described by Agardh, but as some are of much greater diameter than others, I do not attribute much importance to this character ; and in most other respects our specimens seem to agree pretty well. One of mine is well supplied with conceptacles.

8. *GRACILARIA damæcornis*, J. Ag. ; "frond terete, very thick, carnosocorneous, decompound-dichotomous, subfastigiate ; branches sub-erect, often incurved, below subsecundly, above subdivaricately ramulose ; ramuli very patent, acuminate from a broader base." *J. Ag. Sp. Alg.* 2, p. 598.

HAB. On the Atlantic coast of North America, *J. Agardh*.

Unknown to me.

9. *GRACILARIA caudata*, J. Ag. ; "frond terete, thick, carnosio-corneous, elongated and laterally ramulose ; branches below dichotomo-ramulose, above prolonged, nearly naked, segments acuminate ; conceptacles hemispherical, scattered over the whole frond." *J. Ag. Sp. Alg.* 2, p. 598.

HAB. Gulf of Mexico, *J. Agardh*.

Unknown to me.

10. *GRACILARIA?* *Blodgettii* ; frond cartilagineo-membranous, irregularly dichotomous or alternately decompound, filiform, the axils rounded ; branches and ramuli very much attenuated at the base, acute ; fructification unknown.

HAB. Key West, *Dr. Blodgett*. (v. s. in Herb. T.C.D.)

Frond five or six inches long, as thick as sparrow's quill, cylindrical or subcompressed, not much attenuated upwards, irregularly much branched, the branches and their divisions either alternate or secund, here and there forked, but not regularly dichotomous. All the branches and their minor divisions and the ramuli, which are few and scattered, taper very much to the base and are attenuated to an acute point ; the lesser ramuli are spindle-shaped. No fruit has been detected. A cross section shows a lax medullary stratum, formed of a few very large, distended, thin-walled, irregularly polygonal cells, with some smaller but similar external cells ; and a periphery of very minute, vertically subseriate, coloured cellules. *Substance* rather rigid when dry. *Colour* faded in all the specimens yet seen.

A curious plant of doubtful affinity. The ramuli taper to the base fully as much as in a *Chondria*, but there is no articulated polysiphonous axis. The structure is not very different from that of other *Gracilaria*, and the habit is sufficiently like. I have seen no specimens but those received from Dr. Blodgett, to whom this species is inscribed.

VIII. CORALLOPSIS. *Grev.*

Frond subterete, succulent, articulato-constricted ; branches proliferous from the constriction, composed of two strata of cells ; the inner of very large, oblong cells, smaller toward the circumference ; the outer of minute, coloured cellules in a sub-simple row. *Conceptacles* on the primary branches, hemispherical, inflated with a thick pericarp at length opening by a pore, containing on an elevated basal placenta densely tufted, fastigate spore-threads radiating to all sides ; spores obovate, formed in the upper articulations. *Tetraspores* unknown.

Nearly related to *Gracilaria*, from which it chiefly differs in the constricted coral or cactus-like frond.

1. CORALLOPSIS *Salicornia*, Grev.; frond from the base articulo-constricted, di-trichotomous, articulations swollen upwards, club-shaped, three or four branches springing from the summit of each. *J. Ag. Sp. Alg.* 2, p. 582. *Sphærococcus Salicornia*, *Ag. Ic. Ined.* t. 8.

HAB. Unalaschka, *Chamisso*.

Frond 5—6 inches long, articulate throughout; the articulations an inch long, very slender at the base, gradually swollen upwards, truncate and slightly hollowed at the apex. From the summit of each joint spring three or four similar articulations, and thus the frond lengthens proliferously. *Substance* when moistened fleshy, when dry cartilaginous.

This curious plant I only know through the figure and descriptions above quoted.

ORDER V. GELIDIACEÆ.

Hypneaceæ, Gelidiæ and Solieriæ, *J. Ag. Sp. Gen. and Ord. Algarum*, pp. viii. ix. xi. *Part of Cryptonemæ and Sphærococcoideæ*, *J. Ag. Alg. Medit. Endl.* 3d. *Suppl. Harv. Man. Ed.* 2. &c.

DIAGNOSIS. Purplish or blood-red sea-weeds, with an inarticulate, cartilaginous or horny, filiform or flattened frond; the axis (at least) composed of longitudinal confervoid filaments; the superficial cellules minute. *Conceptacles* half immersed, prominent towards one or both surfaces. *Spores* attached either to a net-work of slender filaments filling the cavity of the conceptacle, or to a fibro-cellular placenta which either adheres to one wall of the cavity, or runs through its centre, dividing it into two loculi.

NATURAL CHARACTER. *Root* either discoid or branching. *Fronde*s almost always tufted, often very densely so, and sometimes forming inextricable matted or pulvinate masses, mostly filiform, either cylindrical or compressed, rarely flattened and somewhat leaf-like, generally much branched. The ramification is commonly pinnate, the frond often many times compounded; sometimes it is irregularly alternate or secund, rarely and very imperfectly somewhat dichotomous; sometimes the

sub-simple branches are densely clothed with irregularly inserted ramuli. In *Suhria* and *Ptilophora* the branches are flattened, traversed by a distinct midrib; in the other genera, they are either cylindrical or compressed; in the latter case thickened in the middle, but without a perfect midrib. The structure of the frond varies considerably in minor points, chiefly in the greater or less development of cylindrical, axial cells. In the typical genus *Gelidium* the whole structure is very dense; the axis composed of a bundle of very slender cylindrical cells, associated in filamentous series, and very strongly soldered together; the periphery, of minute roundish cells formed into vertical filaments; and the intermediate stratum, of seriated cellules having a direction partly longitudinal, but curving outwards towards the periphery. The whole frond, therefore, is constructed of confervoid filaments strongly glued together. In *Eucheuma* the axial and peripheric strata, both well developed, have an arrangement not dissimilar to that of the same regions in *Gelidium*, but the intermediate layer is composed of polygonal cellules forming a honey-combed substance. In *Solieria* the axial stratum is very lax, in the young frond made up of a few distantly set anastomosing and interlaced filaments, but gradually with age it becomes dense; still it never attains to the closely interwoven and firm axis of *Eucheuma*; the peripheric layer is very thin, and the intermediate stratum of honey-combed cells forms the larger portion of the frond. At length in *Hypnea* we find an axis reduced to a few slender filaments or even to a single filament; a periphery of one or two rows of minute cellules, and a frond almost entirely constituted of the honey-combed cells belonging to the intermediate stratum. All these varieties of structure appear to constitute a regular series of successive degradations; and though in comparing together *Gelidium* with *Hypnea* the difference is very great, yet when these genera are looked upon as the extreme types of a natural group in one of which the axial, and in the other the intermediate stratum is in excess, I think it will be seen that they are brought together through *Eucheuma* and *Solieria*, which exhibit axial and intermediate strata in various proportions. In external habit, too, and in substance, there is considerable resemblance between the *Gelidia* and the *Hypneæ*.

If, in like manner, we compare the structure of the pericarp and its contents in these genera, I think we shall find a greater similarity than is apparent on a cursory view; taking, as before, *Gelidium* to express the most developed, and *Hypnea* the least developed type of the Order. In all the genera the spore-threads have few articulations, but one or at most two or three spores ripening on each thread. The spores are sometimes pyriform, sometimes roundish, slightly drawn out at one end, but there is no very marked dissimilarity. The tendency is towards the production of pyriform spores, and is more strongly evidenced in some than in others. The great differences are found in the placentation, and these are so marked as to have led Professor Agardh to place in three Orders the genera which I propose to unite under one. To assimilate the placentation we must bear in mind that the placenta originate in this group not at the apex of the mass of axial cellules, or of a lateral branch from the axis, as is the case in the *Sphærococcoideæ*, *Laurenciaceæ*, and *Rhodomelaceæ*, but from the sides of the axial filaments themselves, which are continued through the cavity of the conceptacle from its base to its apex. In most

genera of the Order this is obviously the case, the conceptacle arising from a swelling in the middle of a branchlet which is continued beyond the swollen part. In such a case the portion of the substance which constituted the axis of the frond below and above the conceptacle becomes the placenta while passing through the cavity. In *Eucheuma*, where the whole branchlet is encysted, this structure is less apparent, but the filaments which connect the suspended placenta of that genus with the walls of the conceptacle show that the axis does not terminate at the placenta, these filaments being continuations of it. In *Pterocladia* an anomalous structure arises from a different cause, namely from the conceptacular cavity being formed not at both sides of the axis as in *Gelidium*, but at one side only. The result is, that the portion of the axis that bears spore-threads, instead of passing through the centre of the cavity, occupies its inner face as a parietal placenta.

Taking this view of the placentation, the connection between the conceptacles of *Gelidium* and of *Hypnea* may be easily understood. In *Gelidium*, as has been already said, the axis is in excess, while in *Hypnea* it is deficient; and the placenta being a development of the axis, we should expect a corresponding relation in the placentation of these genera. And such is the case. In *Gelidium* a dense, fibro-cellular placenta, corresponding with the dense axis, divides the conceptacle through the middle of which it runs into two loculi, and bears spore-threads on both surfaces. In *Hypnea* the spore-threads spring from slender, cobweb-like filaments running through the cavity. The structure of *Solieria* is intermediate, there being in the conceptacle of that genus a fibrocellular placenta suspended in the cavity by filaments connected with the surrounding walls, and bearing spore-threads over the whole outward surface. This genus and *Eucheuma*, which has an analogous structure, appear to me to connect *Hypnea* so far with *Gelidium* as to render it advisable to place them in the same group. And possibly *Chaetangium* also, when carefully compared with *Pterocladia*, may be found, notwithstanding its remarkable characters, to have a close relationship.

The Gelidiaceæ, as here defined, are remarkable for their beauty, the sportive forms which many species assume, and the wide geographical range of some. *Gelidium cartilagineum* has been noticed for the brilliant variety of the colours which it puts on under the bleaching action of the sun and air, before it fades altogether; but *Hypnea musciformis*, *Eucheuma isiforme*, and several others are equally brilliant under similar circumstances. *Gelidium corneum*, a most variable plant, is found throughout most parts of the Atlantic and Pacific Oceans, if we except high northern and southern latitudes. It is however both rare and of small size on the eastern coast of North America, though on the Pacific coast it is apparently common and attains large dimensions. *Solieria chordalis*, so abundant on the American shore, is of rare occurrence and rather local in Europe. *Hypnea musciformis* abounds in all tropical and subtropical seas. *Suhria* and *Ptilophora* are only known at the Cape of Good Hope, and *Pterocladia* is one of the most abundant and characteristic of New Zealand Algæ. *Caulacanthus*, associated with *Hypnea* by Professor Agardh, is of doubtful affinity, its conceptacles being unknown; and I rather incline, with Kützinger, to place it near *Endocladia*.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

SUBORDER 1. GELIDIEÆ. *Conceptacles* divided into two cells by a longitudinal axial placenta which bears *spores* on both surfaces.

I. GELIDIUM. *Frond* compressed, rigid, decompound-pinnate.

SUBORDER 2. SOLIERIEÆ. *Conceptacles* having a central, fibro-cellular placenta connected with the walls by slender filaments, and bearing spores on all sides.

II. EUCHEUMA. *Frond* terete, cartilaginous, horny when dry, shrub-like. *Conceptacles* ovate, external, sessile on the ramuli.

III. SOLIERIA. *Frond* terete, succulent, flaccid. *Conceptacles* half immersed in the substance of the filiform branches.

SUBORDER 3. HYPNEACEÆ. *Conceptacles* traversed by arachnoid filaments, to which clusters of spores are attached.

IV. HYPNEA. *Frond* filiform, much branched; branches virgate, clothed with subulate ramuli, their apices often hooked.

1. GELIDIUM. *Lamour. J. Ag. ref.*

Frond firmly cartilaginous, linear, compressed, decompound-pinnate. *Substance* very compact, composed of three strata; the *axis* of densely interwoven, longitudinal, tenacious filaments, formed of very long, cylindrical cellules; the *intermediate* stratum of small polygonal cellules set in diverging lines, the *periphery* of minute cellules arranged in moniliform filaments at right angles with the axis. *Conceptacles* immersed in the ramuli, prominent on both surfaces, two-celled; the dissepiment longitudinal, connected with the walls of the cavity by slender filaments. *Spores* pear-shaped, on slender funiculi, attached to both surfaces of the medial dissepiment. *Tetraspores* cruciate, immersed among the surface cellules, in subdefined sori near the ends of the ramuli.

The frond is distichous, almost always pinnate, rarely subdichotomous with pinnated lesser branches. It is very narrow, compressed or two edged, rarely quite

cylindrical, of a firm, tenacious substance and densely compacted structure, and when dry is very rigid, almost horny. When growing, the colour is a purplish red of greater or less intensity. On exposure to the air or immersion in fresh water and subsequent drying, this purple changes through various brilliant tints of red, orange and yellow to a waxy or glassy white, retaining a polished surface even when completely bleached. Both kinds of fructification are lodged in the smaller ramuli or pinnules, at some distance below their extremity. The *tetraspores* form little sori, or cloudy patches, and generally occur in slightly expanded, obtuse ramuli, sometimes in the ordinary pinnules and sometimes in minute accessory or special processes of the rachis. The conceptacles whose remarkable structure was first, I believe, correctly described by Prof. J. Agardh (*Advers.* p. 42) are very curious and beautiful microscopic objects. They are formed in the substance of the fertile ramulus, rising towards each of its flat surfaces like little hollow blisters, opposite each other, leaving as a dissepiment between them the flattened axial stratum of the branchlet; so that it would be more correct to describe them as binate, opposite conceptacles, than as a two-celled conceptacle, which is the apparent structure.

1. *GELIDIUM corneum*, Lamour.; frond two edged, flat or sub-terete, purplish red, two to four times pinnated; pinnulæ narrowed at base, linear, entire, obtuse, rarely subacute, those containing the tetraspores club-shaped or obovate, very obtuse; conceptacles below the apex of the ramulus. *Harv. Phyc. Brit. t.* 53. *J. Ag. Sp. Alg.* 2, p. 469. *Kütz. Sp. Alg.* p. 764. *Fucus corneus*, Huds.—*Turn. Hist. t.* 257. *E. Bot. t.* 1970.

HAB. Pacific and Atlantic Coasts. Russian America, *Postells and Ruprecht*. California, *Dr. Coulter, Capt. Pike*. Portland, Maine, *Capt. Pike* (54). Red Hook, New York Bay, *Mr. Hooper, Mr. Walters, &c.* Sullivan's Island, Charleston, *Prof. Gibbs, W. H. H.* (v. v.)

A most variable plant. Dr. Coulter's Californian specimens are three or four inches high, broadly ovate in outline, the lower branches being long, the upper gradually shorter, very densely set and about three times pinnated; the pinnæ and pinnules patent, tapering to the base, very blunt at the apices, either rounded or subtruncate. The colour is a dark brownish purple. The specimens from New York and Maine are very much smaller, rarely more than an inch and half high, scarcely thicker than hog's bristle, less strongly compressed and more flabelliform in outline, the frond and its principal branches being naked below, and pinnated only above the middle. The Charleston specimens are very similar, but less decompound and the ramuli are not so blunt. These latter are in conceptacular fruit, the conceptacle lodged about the middle of the pinnules, or occasionally even in one of the pinnæ toward the base.

2. *GELIDIUM serrulatum*, J. Ag. ; "caulescent, stem two-edged, naked below ; frond three to four times pinnate ; pinnules dilated from a narrower base, cuneate-linear, the younger serrulate at the margin, the fertile subsimple, obovate, serrated, curled and twisted, containing numerous tetraspores." *J. Ag. Sp. Alg.* 2, p. 472.

HAB. Gulf of Mexico. At Guayra, Venezuela, *Liebman*.

This is said to resemble a robust state of *G. corneum*, from which it is readily known by the serrulated pinnules.

3. *GELIDIUM cartilagineum*, Grev. ; root much branched ; frond elongate (12—18 inches) two edged, purple or changeable, decompound-pinnate ; pinnæ patent, with rounded axils, linear, very entire, somewhat flexuous, twice or thrice compound ; pinnules mostly opposite ; tetraspores in the incrassated tips of the ultimate pinnules. *Harv. Phyc. Brit. t.* 337. *J. Ag. Sp. Alg.* 2, p. 473. *Kütz. Sp. Alg.* 763. *Fucus cartilagineus*, *Turn. Hist. t.* 124. *E. Bot. t.* 1477.

HAB. California, *D. Douglas* ; *Dr. Coulter* ; *Lieut. Wood.* (v. v.)

Root a mass of much branched, rigid fibres. *Fronds* in our Californian specimens about twelve inches long, a line in diameter, compressed, two-edged, becoming flatter upwards, three or four times pinnate. *Stems* naked in the lower half, pinnated above the middle ; primary pinnæ elongate, patent, alternate or sub-opposite, naked below, pinnate or bi-tri-pinnulate above. All the lesser pinnules issue at very obtuse angles, with a distinctly rounded axil ; they are either alternate or opposite, sometimes quite simple, sometimes decompound. Specimens with *tetraspores* have generally more sub-divided pinnules, the tetraspores being lodged in the thickened, gland-like apices. *Substance* cartilaginous, horny when dry. When growing the colour is very dark brownish purple-red, but on exposure to the air it changes through various brilliant tints of red, orange, yellow, and greenish to a horny white. It does not adhere to paper in drying.

4. *GELIDIUM Coulteri* ; frond very narrow, plano-compressed, sub-naked below, decompound-pinnate above ; pinnæ close together, distichous, once or twice compounded, pinnules tapering to the base, acute, the fertile ones spindle-shaped, acute and often aculeate.

HAB. California, *Dr. Coulter.* (v. s. in Herb. T.C.D.)

Densely tufted, three or four inches high, less than half a line in breadth, compressed or two-edged, bare of branches below, closely pinnate above the middle ; the pinnæ one or two lines apart, of various lengths, the lowest longest and most compound, once or twice pinnulated. *Pinnulæ* closely set, distichous, the lower

ones short, subulate, acute, simple, the upper longer and once or twice compounded with similar pinnules. All the pinnules are acute, more or less constricted at their insertion, and many of them denticulate at the margin or set with distichous, tooth-like ramuli, which probably afterwards lengthen into pinnules. The fertile pinnules (containing *tetraspores*) are incrassated in the middle, spindle-shaped, and very generally furnished with marginal spine-like processes. *Colour* a very dark, blackish purple. *Substance* rigid, horny when dry. It does not adhere to paper.

In aspect this plant is most like *G. spinulosum*, J. Ag., but the fertile ramuli are very different.

II. EUCHEUMA. J. Ag.

Frond terete or plano-compressed, carnosio-cartilaginous, horny when dry, decompound, usually spiny or tuberculated, solid, composed of three strata; the *medullary* stratum, of densely interwoven, elongated, anastomosing longitudinal filaments; the *intermediate*, of several layers of roundish-angular cells, gradually smaller outwards; the *cortical*, of minute, coloured cellules set in radiating filaments, at right angles to the axis. *Conceptacles* ovate, sessile on the ramuli, furnished with a terminal pore, containing within a very thick pericarp a central, fleshy *placenta* suspended within the cavity, and attached by numerous confervoid filaments to the walls; *spore-threads* simple or branched, issuing from all sides of the placenta, moniliform, three or four roundish, oblong, or sub-pyriform *spores* formed in each thread. *Placenta* often hollow. *Tetraspores* immersed in the cortical stratum, scattered, zonate.

This genus is formed, by Prof. J. Agardh, for several tropical or sub-tropical Algæ with shrub-like, robust, cartilagineo-corneous, mostly spinous, tuberculated fronds. They were formerly placed either in *Sphærococcus*, *Gracilaria*, *Hypnea* or *Gigartina*, from all which genera, as now understood, they differ in structure and fructification. The conceptacles, however, are only known with certainty in our American species, and have a structure in some respects connecting the *Sphærococcoideæ* (among which Prof. Agardh now arranges this genus) and the *Gelidiaceæ*, as here defined. To me the placentation appears so similar to that of *Solieria* that I am unwilling to separate these genera widely; while I admit that the moniliform spore-threads show an affinity with *Gracilaria*.

1. *EUCHEUMA isiforme*, J. Ag.; frond fruticose, very robust, decompound, much branched; branches spreading to all sides, the lesser branches often opposite or

whorled, simple, whorled at short intervals with broadly subulate, acute or obtuse, spine-like ramuli. *J. Ag. Sp. Alg.* 2, p. 627? *Sphærococcus isiformis*, *Ag. Sp. Alg.* 1, p. 271? *Kütz. Sp.* p. 777. *Hypnea Wurdemanni*, *Harv. MSS.* (TAB. XXIV.)

HAB. Abundant at Key West, *Dr. Wurdeman*, *Dr. Blodgett*, *W. H. H.* Bahia Honda, *Prof. Tuomey.* (v. v.)

Tufts a foot or more in diameter, globose, composed of many stems branching in all directions from a central point. *Stems* of the larger specimens nearly half an inch in diameter at base, soon dividing into several simple branches six or eight inches long, as thick as swan's quills at the base, tapering gradually to the diameter of a crow's quill at the summit, furnished throughout, at distances of two or three lines, with lateral, opposite, whorled, or scattered secondary branches which spread to all sides. These branches are from four to six inches long and in large specimens bear another series of similar branches. They, as well as the main stem, are nodose or swollen at short intervals, the nodes armed with three or four or more verticillate, spreading spines. *Spines* one to three lines long, from a broadly conical base tapering to an acute point; in old specimens and toward the base of the larger branches obtuse, mamillæform or sub-obiterated. The ends of the branches are sometimes incrassated into a subglobose head, which is either simple or lobed and plaited like the inflorescence of *Celosia cristata*. In fertile specimens the whorled spine-like ramuli are much less regularly disposed. *Conceptacles* borne on the ramuli, one, two or more on each ramulus, variously placed, often terminal, ovate, with a minute pore; walls very thick, composed of two strata, the inner of many rows of polygonal cells, the outer of radiating moniliform filaments: *placenta* central, suspended in the cavity by numerous, confervoid filaments connecting it on all sides with the walls of the conceptacle, cellular, often hollow within, bearing moniliform, densely crowded, simple or branched *spore-threads* on every side. *Spores* roundish oblong, the terminal one sub-pyriform. I have not seen *tetraspores*. *Colour* when recent a dark full red, becoming scarlet, orange and yellow, and at length semitransparent and horn-like on exposure. *Substance* firmly cartilaginous. In drying, the frond shrinks very much, and if strongly pressed will adhere, though imperfectly, to paper.

The first specimens of this truly noble plant which I received were collected by the late Dr. Wurdeman, and, believing them to belong to an undescribed species, I wished to bestow his name upon it. Afterwards, on carefully reading the character given by the elder Agardh of his *Sphærococcus isiformis*, described from West Indian specimens, it appeared to me that it had many points in common with Dr. Wurdeman's plant, and I therefore communicated by post a small branch of the latter to Professor J. Agardh, requesting him to compare it with that described by his father, and to give me his opinion as to their identity. In reply he informs me that our Key West plant "looks like a different, though nearly related species; the *S. isiformis* Ag. being a far more gelatino-cartilagineous and coarser plant, with a somewhat different and transparent tint of red, and all the spines obtuse, even the young ones." This opinion was formed on a small branch such as could be sent in

a half ounce letter, but I fear the differences indicated do not amount to specific characters; for I find, among some hundred specimens which have passed through my hands, great diversity in diameter and in the comparative obtuseness of the spines; and the colour depends very much on the longer or shorter exposure to alternate sunlight and rain. Should, however, future observations show that I have confounded two species, the present will, I hope, bear the name of Dr. Wurde-man, its estimable discoverer at Key West.

Plate XXIV. *Fig. 1.* EUCHEUMA *isiforme*, the *natural* size. *Fig. 2*, part of a branch with conceptacles; *fig. 3*, section of a conceptacle; *fig. 4*, spore-threads; *fig. 5*, semi-section transversely of a branch; *fig. 6*, a longitudinal section through the same; more or less *magnified*.

III. SOLIERIA. *J. Ag.*

Fronde cylindrical, subcartilaginous, succulent, fruticose, composed of three strata; the *axis* (or *medullary* stratum) consisting of longitudinal, anastomosing filaments; at first few, afterwards densely interwoven; the *intermediate* stratum of several rows of roundish cells, of which the inner are large, the outer successively smaller and more angular; the *cortical* of two or three rows of minute, coloured cellules. *Conceptacles* immersed in the axial region of the branch, but prominent to one side, the walls formed of a dense plexus of filaments derived from the axis; *placenta* fibrocellular, central, suspended in the cavity by slender filaments connected with the walls: *spores* pedicellate, pear-shaped, covering the whole surface of the placenta. *Tetraspores* transversely parted, (*zonate*) dispersed among the peripheric cellules of the branches and ramuli.

The *frond* is cylindrical, irregularly branched, of a somewhat tender substance, crisp when quite recent, but soon becoming flaccid. When young the axis is exceedingly lax, and the branches are almost hollow, the axial region being occupied by a watery gelatine, through which a few distant, longitudinal, anastomosing filaments are dispersed. Toward the base of the frond and in older specimens the axis is much more dense, and finally, when the growth is fully matured, it becomes a compact plexus filling up the vacant space, and solidifying the branch. The *intermediate* stratum, or the region between the axis and coloured periphery, in like manner, becomes more compound with age, the addition of new cells being made on the outside; and the cells of the innermost row are always of much greater diameter than those of the exterior rows. The *periphery* does not undergo much change. The *conceptacles* appear externally like obtusely conical tubercles with a dark coloured core, scattered profusely over the branches of fertile specimens. A

cross section through one of them shows that they are deeply sunk in the substance of the branch, being wholly formed out of a portion of the axial filaments. The walls are constructed of filaments, derived from the axis, and very densely interwoven together, and invest the sporiferous nucleus on all sides, enclosing it as within a sac. Numerous slender filaments proceed from the inner face of the walls to a central placenta, formed likewise of a dense plexus of filaments. The whole exterior surface of the placenta is densely clothed with pedicellate, oblong or pear-shaped spores, which are either simple, or (perhaps with age) divided transversely into two or more, chained sporules. The tetraspores are of small size, and scattered without order through the surface cells of the branches and ramuli.

In external habit and even in the internal structure of the frond there is a very close similarity between the species of this genus and of *Rhabdonia*, so much so, indeed, that it is impossible to tell, without examining the conceptacular fruit, to which of these genera any individual specimen may belong. The sporiferous nucleus is however very different, but I know of no other characters by which to distinguish *Rhabdonia*; and before I became aware that the American specimens now to be described were identical with the European *Solieria chordalis*, I had referred them without hesitation to *Rhabdonia*. The genus *Solieria* was founded by Prof. J. Agardh on an Alga first found at Cadiz, and which had been referred by the elder Agardh originally to *Sphærococcus*; then to *Delesseria*; and which was afterwards associated with *Gracilaria* by Dr. Greville, and with *Gigartina* by Dr. Montagne, from all which genera, as now reformed, it is needless to say that it is abundantly different. In external habit it most resembles *Gracilaria* (*Plocaria*), and may even be confounded with *G. compressa*; and before structure of frond and of nucleus were minutely examined it might very well have found a place in the group so called. Though originally observed in Europe, it seems to be much more abundant along the American shore, where its range extends from Long Island to Florida.

1. *SOLIERIA chordalis*, J. Ag.; frond alternately decompose; lateral branches long, virgate, tapering to the base and apex, and furnished with more or less copious linear-fusiform, acuminate ramuli; conceptacles copious, half immersed in the branches. *J. Ag. Alg. Médit.* p. 157. *J. Ag. Sp. Alg.* 2, p. 723. *Kütz. Sp. Alg.* p. 748. *Delesseria chordalis*, *Ag. Sp. Alg.* 1, p. 189. *Gigartina Gaditana*, *Mont. in Webb. Ot. Hisp. t.* 7. (TAB. XXIII. A.)

HAB. Abundant in Long Island Sound, from Cape Cod to New York, *Prof. Bailey, &c.* Longbranch, New Jersey, *Miss Morris*. Charleston Harbour, *H. W. Ravenel, Esq. and W. H. H.* Apalachicola, *T. Drummond, Dr. Chapman*. Key West, *W. H. H.* (v. v.)

Frond from six to twelve or fourteen inches long, from half a line to nearly two lines in diameter, much branched but very variable in the ramification. Commonly a subsimple stem is set throughout at short distances with many lateral branches, of which the lowest are longest, the rest successively shorter upwards. These branches

are six or eight inches long, undivided, but furnished with copious lateral secondary branches, which are either similarly decompound once or twice or are furnished with a few scattered, short, erect or spreading ramuli. Sometimes the division is carried on to many sets of alternate branches and ramuli, and then the fronds are exceedingly bushy; sometimes the frond divides near the base into many virgate branches having a second series of naked secondaries, two to four inches long. All the lesser branches and ramuli are linear-fusiform, tapering to a much contracted base and attenuate to a fine point. *Conceptacles* obtusely conical, half sunk in the branches and ramuli, through which, in fertile specimens, they are plentifully scattered. *Tetraspores* dispersed. *Colour* a dark red, becoming blood red on exposure. *Substance* somewhat cartilaginous, but tender, decomposing in fresh water. In drying, it shrinks much and closely adheres to paper.

I have many varieties of this sportive plant from the American shores. At Fort Hamilton, New York, Mr. Hooper pointed out to me a squarrose form of a very dark colour, more slender than usual, the branches distorted and very irregular and the ramuli either patent or recurved: and Capt. Pike and Mr. Calverley have since communicated many similar specimens from Red Hook. At first sight this form looks very distinct from the deep-water varieties, but the microscopic structure is the same, and I hesitate to separate it specifically. The Apalachicola specimens also have a slightly different aspect from the common form.

Before I had seen the fructification of this species I believed it to be a *Rhabdonia* and had distributed it among my friends as *R. Baileyi*, named in compliment to Prof. Bailey, from whom I received the earliest specimens. It so perfectly resembles in ramification the West Indian *R. tenera*, J. Ag. that except by the structure of the sporiferous nucleus, which Prof. Agardh has examined in the latter, I do not see how they are to be distinguished.

Plate XXIII. A. *Fig. 1.* *SOLIERIA chordalis*, the natural size. *Fig. 2.* longitudinal section of a branch, with tetraspores in situ; *fig. 3.* tetraspores; *fig. 4.* transverse section through a branch and conceptacle; *fig. 5.* small portion of the same, to show structure more plainly; *fig. 6.* spores; the latter figures more or less highly magnified.

IV. HYPNEA. *Lamour.*

Frond cylindrical, cartilaginous, irregularly much branched and set with awl-shaped ramuli. *Axis* consisting of a few slender, longitudinal filaments or filiform cellules, (sometimes wanting); *intermediate* stratum of several rows of oblong, polygonal cells, void of endochrome; *periphery* of one or two rows of minute, coloured cellules. *Conceptacles* hemispherical, without orifice, formed on the ramuli, and containing numerous roundish clusters of pedicellate spores attached to slender, partially anastomosing filaments which traverse the cavity. *Tetraspores* transversely parted (*zoned*), clustered together in swollen ramuli.

The fronds in all the species are much branched, and generally densely tufted, sometimes formed into cushion-like or mossy mats, whence the generic name, derived from *Hypnum*, a well known genus of mosses. The branches are frequently virgate, clothed throughout with awl-shaped, spreading or divaricated ramuli; but there is much difference in ramification between the sterile and fertile fronds of the same species, which makes the determination of these plants often a matter of no small difficulty.

In arranging the American species, I gladly adopt the views of Prof. J. Agardh, who in his recent admirable work (*Sp. Gen. et Ord. Algarum*, vol. 2, p. 438-455) has revised the genus, casting out Algæ which had been erroneously placed in it, and establishing the true congeners on a more certain basis. And I may take this opportunity of confessing that I have myself been guilty in this matter, having formerly associated with *Hypnea*, *Cystoclonium purpurascens*, a plant of very opposite affinities.

SECTION 1. VIRGATÆ. Sterile fronds tufted, with virgate branches clothed with subulate ramuli, the older ramuli constricted at the base; *tetrasporiferous* fronds similar, having tetraspores immersed in pod-shaped ramuli; *conceptaculiferous* fronds divaricately much branched.

1. *HYPNEA musciformis*, Lamour.; fronds tufted, virgately branched; branches filiform, in the lower part clothed on all sides with subulate ramuli, incrassated and somewhat naked below the apex, which is often strongly hooked inwards; mature ramuli tapering to both ends; those bearing tetraspores incrassated and pod-like in the middle; those with conceptacles spinescent, divaricately branched. *J. Ag. Sp. Alg.* 2, p. 442. *Kütz. Sp. Alg.* p. 758. *Hypnophycus musciformis*, Kütz. *Phyc.* t. 60, fig. 4. *Fucus musciformis*, Wulf.—*Turn. Hist.* t. 127. *Esper*, t. 93.

HAB. New Bedford, Massachussetts, *Dr. M. B. Roche*. Sullivan's Island, South Carolina, *Prof. Gibbes*, *W. H. H.* Anastasia Island, *Dr. Durkee*. Key West, *Mr. Binney*, *W. H. H.*, *Dr. Blodgett* (17), *Prof. Tuomey* (19). Pine Islands and Key Biscayne, *Prof. Tuomey* (8, 11, 32). Pacific Coast, at Nootka Sound, *Mr. Menzies*, 1787. (v. v.)

Fronds densely tufted, four to eight inches long, as thick as sparrow's quill below, attenuated upwards, irregularly decompound, generally with an evident stem set with copious, lateral, virgate branches, the lowest of which are the longest, and most of them, as well as many of the secondary branches, incrassated toward the apex and strongly hooked or revolute, sometimes circinate. *Branches* once or twice compound, for three-fourths of their length furnished on all sides with very slender subulate ramuli, one to three lines long, as thick as hog's bristle, acute, at length constricted at the base, patent, densely or laxly set, gradually fewer toward the ends of the branches, where, especially in the incrassated and hooked extremities, they are secund along the outer side of the branch. In some specimens these

ramuli are very densely crowded, so that the branches are completely echinate with them, in others they are few and far between. *Tetraspores* zoned, lodged in pod-like swellings in the middle of fertile ramuli. The *capsuliferous* plant (of which I have not seen American specimens) has the branches everywhere clothed with divaricately branched, spinous ramuli, on which the conceptacles are formed. *Colour* a dark purple, changing to green, or occasionally into a coral red. *Substance* cartilaginous and brittle when recent. In drying, it shrinks and adheres imperfectly to paper.

2. *HYPNEA* (?) *crinalis*; stem elongated, subsimple; branches lateral, closely set, virgate, very long, filiform, setaceous, attenuated, straight, having a few scattered, subulate, erect ramuli; fructification unknown. *Harv. MS. in Herb. T. C. D.*

HAB. California, *Dr. Coulter.* (v. s. in Herb. T. C. D.)

Stems ten to twelve inches long or probably more, as thick as hog's bristle or somewhat thicker, undivided, filiform, furnished throughout at intervals of two or three lines with long, simple, similar branches, 6—8 inches long, about the thickness of horsehair, attenuated, naked or having a few, minute, subulate, erect ramuli scattered along them. *Ramuli* generally two or three lines apart, about a line long, erect or erecto-patent, sometimes copious, sometimes nearly wanting. *Colour* a dark brownish purple. *Substance* cartilaginous. *Fruit* unknown. *Structure* rather different from that of the genus, the peripheric stratum being developed into moniliform strings of cellules.

This has the external habit of *Hypnea*, but till its fructification shall be discovered must remain among the doubtful species, as its structure is somewhat different from the typical. Its cells do not readily expand in water, and muriatic acid dissolves the membranes rapidly, so that I have not been able to obtain as clear a view of the internal cells as I could wish.

SECTION 2. SPINULIGERÆ. *Sterile* fronds intricately tufted, branches patent, alternately decompound, and beset with thorn-like ramuli acuminate from a broad, conical base; *tetrasporiferous* fronds similar, having tetraspores immersed in the base or swollen middle of the ramuli.

3. *HYPNEA divaricata*, Grev.; intricately tufted, alternately branched; branches not projecting far beyond the tuft, spinulose throughout, less beset toward the straight apices; spines spreading on all sides, the upper ones sub-secund, patent, simple or compound, acuminate from a broad base; tetraspores lodged in the tumid bases of the ramuli; conceptacles three or four together on divaricate, branching ramuli." *J. Ag. Sp. Alg.* 2, p. 448. *Kütz. Sp. Alg.* p. 759. (Excl. Syn. Turn.)

HAB. On the shores of the Gulf of Mexico, *Liebman, fide J. Ag.*

I have not seen any American specimens of this plant, which I know only from Australian and Mauritian examples.

4. *HYPNEA cornuta*, J. Ag. ? frond decompound, irregularly much branched ; branches widely spreading, both larger and smaller laxly set with scattered, spirally inserted, divaricating, broadly subulate, acute ramuli, which are either simple or forked, and occasionally fasciculate ; ends of the branches sometimes naked, straight." *J. Ag. Sp. Alg. vol. 2, p. 449.*

HAB. Key West, *Prof. Tuomey*, (7 and 33^a), St. Croix, *Miss Dix*.

Frond (in my specimens) three to four inches long, as thick as sparrow's quill, attenuated upwards, very much branched ; the branches alternate or secund, one or two lines asunder, short and long irregularly mingled together, widely spreading with obtuse axils, decompound three or four times ; their apices produced and somewhat bare of ramuli, straight, simple or dichotomous. *Ramuli* more or less copious, scattered along the larger and smaller branches, very patent or divaricate, half a line to a line long, subulate, rising from a broad base, very acute, simple or forked, sometimes two or three from the same point. *Colour* a full dark red. *Substance* cartilaginous.

I have not seen any authentic specimen of Agardh's plant to which I refer the specimens described. His specific character is as follows :—" *H. cornuta* ; cæspitosa alterne ramosa, ramis extra cæspitem parum porrectis, per totam longitudinem laxè spinulosis apice subdenudato-rectiusculis, spinulis quoquoersum egredientibus patentibus, aliis simplicibus a basi latiore acuminatis rigidis, aliis stellulæformibus vivide rubris, capsuligeris rectis spinulis simplicibus obsitis."

5. *HYPNEA cervicornis*, J. Ag. ; "intricately tufted, sub-decumbent, divaricately much branched and beset with similarly divaricately branched ramuli ; fertile branches projecting beyond the tuft, more densely ramulose, ramuli spreading on all sides, very patent, mostly ramellose ; those bearing tetraspores tumid above the base, ending in a simple or branching point ; those with conceptacles similar." *J. Ag. Sp. Alg. vol. 2, p. 451.*

HAB. Gulf of Mexico, on the Mexican coast, *Liebman*, *fide J. Agardh*.

SECTION 3. PULVINATÆ. *Sterile* fronds densely pulvinate, intricately much branched, the branches concrete, cohering ; *fertile* emerging beyond the matted tuft, not entangled together.

6. *HYPNEA pannosa*, J. Ag. ; sterile fronds pulvinate, intricately much branched, branches concrete, the exterior ones conical, acuminate ; fertile ones emerging

beyond the tuft, naked at the base, pyramidally branched beyond the middle ; branches thick, rather obtuse, those bearing tetraspores sub-unilaterally warted at the base and pod-like below the apex, containing one or more sori. *J. Ag. Sp. Alg. vol. 2, p. 453.*

HAB. On the Pacific coast of the Mexican Republic, *Liebman.*

ORDER VI. SPONGIOCARPEÆ.

Spongiocarpeæ, Grev. *Alg. Brit.* p. 69. . *Part of Cryptonemiæ*, *J. Ag. Alg. Medit.* p. 81. *Endl. 3d Suppl.* p. 36. *Harv. Man. Ed. 2, p. 131.* *Part of Gigartineæ*, *Kütz. Sp. Alg.* p. 724. *Part of Chondrieæ*, *J. Ag. Sp. Gen. and Ord. Alg. vol. 2, p. x.*

DIAGNOSIS. Brown-red, cartilaginous, fruticose (cylindrical and branching) seaweeds, almost wholly composed of confervoid, interlaced filaments closely set in firm gelatine. *Sporiferous nucleoli* numerous, globose, many associated together in external, wart-like, amorphous excrescences, formed of vertical, confervoid, filaments. *Spores* large, obconical, radiating from a central point of each nucleolus.

NATURAL CHARACTER. *Root* an expanded fleshy disc. *Frond* cylindrical, firmly cartilaginous, shrub-like, dichotomously branched, composed of three sub-distinct strata of cells, all disposed in filamentous series. The *medullary* layer, occupying more than half the diameter of the frond, is composed of densely packed, longitudinal, elongated, cylindrical, branched and anastomosing filaments, from which are given off towards all sides the filaments of the *intermediate* layer. These are composed of large, elliptical, ovate, or oblong, coloured cells, set in dichotomous filaments which curve outwards, gradually passing from an erecto-patent to a horizontal position. From the ends of these filaments spring those of the *cortical* layer, which are perfectly horizontal, (that is, vertical to the surface of the erect branches), very slender, composed of minute oblong cells formed into dichotomous, fastigate series. The ends of these filaments, more deeply coloured, constitute the periphery.

In specimens about to produce *spores*, the cortical layer grows out in places into oblong, irregularly shaped *warts* which extend along the branches, sometimes for the space of half an inch. These warts are of a pale, flesh-colour, and wholly

composed of slender, dichotomous filaments, exactly like those of the cortical layer from which they spring. Among these filaments, within the wart, are formed innumerable globose *nuclei* or *spore-clusters*, attached to the filaments; each surrounded by a broad pellucid limbus and consisting of many obconical spores radiating from a minute central placenta. Each *spore* is enclosed in a gelatinous *perispore*; and the pellucid limbus which surrounds the nucleus seems to be formed by the contact of the numerous gelatinous perispores. It is therefore to be regarded as spurious.

Tetraspores are formed in the upper, slightly swollen branches. They are deeply sunk among the peripheric filaments, oblong, and at length cruciately parted.

This Order is founded on a single genus composed of a solitary species, so remarkably distinguished by its fructification from all other known genera of Algæ that it can scarcely be referred without violence to any established group. In external habit of the frond, as well as in internal structure, there is a very close resemblance between *Polyides* and *Furcellaria* (a genus of *Cryptonemiaceæ*), so close indeed that these two genera have frequently been united, and even in the last work of Professor Kützinger, an author not remarkable for avoiding generic analysis, *Polyides rotundus* is described as a species of *Furcellaria*. In the fructification of these genera, however, there is so wide a difference that if we are to regard structure of the sporiferous nucleus as a surer guide to natural affinities than structure of frond, we must place them at nearly opposite ends of the systematic arrangement. Another and very opposite affinity for *Polyides* has recently been indicated by Professor J. Agardh, who, in his tabular distribution of the Floridæ, places it among his *Chondriæ*, the proper type of which group is *Laurencia*. This relationship is no doubt inferred from the size and form of the spores, which may be compared with those of *Lomentaria* rather than with those of any other of the *Chondriæ*; but in the absence of any indication of nearer affinity between these genera, the mere form of the spores will hardly be thought sufficient. The appearance and structure of the fronds are very dissimilar, and the details of the fructification abundantly unlike. In the *Chondriæ* (our *Laurenciaceæ*) a single sporiferous nucleus is enclosed in a hollow conceptacle, formed out of the end of a truncated branch, and of the most perfect type which the conceptacle attains among the RhodospERMATOUS Algæ. The contained nucleus is attached to a basal placenta, and therefore terminates the axis of growth. Such a structure is extremely different from what we have above described in *Polyides*, and though very unwilling to multiply Orders, I cannot consent to the ordinal association of genera differing so widely in fructification. In my opinion *Polyides* is more nearly related either to the *Gelidiaceæ* or *Helminthocladiæ*, though scarcely to be placed among either. In the external aspect of the fruit there is much resemblance to *Peyssonnelia*, but much dissimilarity in the nature of the nucleus. So long ago as 1830 Dr. Greville proposed *Polyides* as the type of a separate Order, and I now revert to his views.

I. POLYIDES. *Ag.*

This being the only genus, the character is the same as that of the Order.

1. *Polyides rotundus*, Grev. *Alg. Brit.* p. 70, t. 11. *Harv. Phyc. Brit.* t. 95. *Polyides lumbricalis*, *Ag. Sp. Alg.* 2, p. 392. *Spongiocarpus rotundus*, Grev. *Fl. Edin.* *Furcellaria lumbricalis*, Kütz. *Sp. Alg.* p. 748. *Phyc. Gen.* t. 72. *Fucus rotundus*, Turn. *Hist.* t. 5. *E. Bot.* t. 1738.

HAB. Boston Bay, Mr. G. B. Emerson, Capt. Pike. Newport, Rhode Island, Prof. J. W. Bailey. (v. v.)

Root a spreading disk. *Fronde*s several from the same base, two or more inches high, as thick as crow-quill, rising with an undivided stipe to a third or a fourth of the height, then forking, and afterwards repeatedly dichotomous. The axils are rounded, the apices somewhat attenuated and sub-acute, of equal length, giving the frond a fan-shaped outline when spread on paper. *Colour* a very dark red brown. *Substance* cartilaginous. It does not adhere to paper in drying.

Our American specimens are of small size, about two inches high, and are not in fruit. In all characters of structure, &c. they are the same as the European.

ORDER VII. SQUAMARIEÆ.

Squamariæ, J. *Ag. Sp. Gen. and Ord. Alg.* 2, p. 485. *Part of Spongiocarpeæ*, J. *Ag. Alg. Medit.* *Harv. Man. &c.* *Part of Chætophoreæ and Porphyreæ*, Kütz.

DIAGNOSIS. Lichenoid, encrusting or horizontally expanded red-brown seaweeds, rooting by the under surface, composed of vertical filaments closely set in firm gelatine. *Spores* in moniliform strings lodged in external wart-like excrescences formed of vertical, confervoid filaments.

NATURAL CHARACTER. This Order is designed to include several anomalous Algæ which agree in a common habit, so far as the frond is concerned, but whose

fructification is yet too imperfectly known to enable us to declare whether the connection be one of analogy or of affinity. Of the eight genera placed here by Prof. J. Agardh, the sporiferous nucleus is known only in one. It is therefore premature to say much of the *natural character* of the Order.

The plants here associated are either gelatinous, cartilaginous, coriaceous or membranaceous expansions, more or less completely attached by their under surfaces to the substances on which they grow. Some few are parasitic on other Algæ, but the greater number adhere to rocks and stones either in the sea or in fresh water streams or rivers. The crust is irregularly orbicular, enlarging by successive additions to its margin, and in the membranous genera is sometimes furnished with concentric lines of growth. In the least developed genus (*Actinococcus*) the whole frond, scarcely more than a line in diameter, is globose, composed of moniliform filaments set in transparent gelatine, and radiating from a common base. Of this type two species, parasitic respectively on *Chondrus crispus* and *Phyllophora Brodiaei*, and which may therefore be expected to occur on the North American coast, have been described. *Petrocelis* and *Cruoria* form widely expanded, skin-like patches of a firmly cartilaginous substance, and dull purple brown or occasionally olive green colour, on the surface of rocks and stones between tide marks in Northern Europe. Like *Actinococcus* they consist of beautifully beaded strings of cells set in gelatine. *Hildenbrandtia* forms thinner and more decidedly membranous, red, or brown-red skins, sometimes merely films, on stones and pebbles, and differs from the preceding as well by the much denser structure of the frond as by having *tetraspores* lodged in minute cavities indicated by dotlike pores scattered over the surface of the crust. In its structure and in this fructification there is some affinity with *Melobesia*, but it wants the deposit of carbonate of lime which distinguishes that genus.

Some or all of the genera just named are probably represented on the North American coast, but in the absence of positive evidence of the fact I can do no more than request the attention of collectors to them. They are all obscure looking, unattractive plants, which may easily escape detection.

I. PEYSSONNELIA. *Dne.*

Frond membranaceous or coriaceous, horizontally expanded and rooting by fibrils emitted from the lower surface, composed of two strata of cellules; the lower stratum of horizontally elongated, cylindrical cellules disposed in radiating filaments cohering laterally into a membrane; the upper of vertically elongated cellules, also arranged in concrete filaments at right angles with those of the lower stratum. Fruit of both kinds lodged in superficial warts composed of vertical confervoid filaments. *Spores* roundish, in moniliform strings. *Tetraspores* oblong, cruciate.

The frond expands horizontally, and is either closely adnate to the substances on which it lies and to which it is attached by means of minute, root-like processes, forming a thin downiness on the lower surface, or it is attached by its lower half only and free at the extremities. It is either orbicular or variously lobed at the margin, the lobes fastigate, circumscribed by a curved line and more or less fan-shaped, often lying on one another in an imbricate manner, and marked on the upper surface by faint concentric lines of growth. The substance in the smaller species is delicately membranaceous, in the larger, thicker and more leathery. The structure is entirely composed of cylindrical cellules twice or thrice as long as their diameter and firmly set in filaments which closely cohere together and form the membranous or coriaceous substance. These filaments are disposed in two strata. The lowest are horizontal, radiating from a central point in the orbicular fronds, and from the base of the fan-shaped ones; they form the substratum or basis of the membrane, and by their development determine its limits. From the upper surface of the membrane so formed spring the obliquely vertical filaments of the upper stratum which are closely combined into a crust of greater or less thickness, their length determining the thickness: and as they arise from the radiating filaments of the lower membrane, their terminal cells also form radiating lines on the upper surface.

The fructification is lodged in shapeless, depressed warts irregularly scattered over the upper surface, and formed of vertical confervoid filaments resembling those of the upper stratum but less closely concrete. These warts sometimes contain *spores*, and sometimes *tetraspores*, on separate plants. The *spores* are formed consecutively, one in each cell of the vertical filaments, and are therefore set in moniliform strings, simple or branched according to the nature of the filaments composing the wart. A portion of the wart is thus converted into a sporiferous nucleus, the remainder consisting of barren paranemata which serve the purposes of a conceptacle. The *tetraspores*, in the warts which produce them, are lodged among the bases of the paranemata, several in the same wart, but never placed in strings, each tetraspore being formed of an arrested and transmuted filament. They are pedicellate and at maturity divide into four equal parts placed crosswise.

The type of this singular genus is the *Fucus squamarius* of Gmelin (*Turn. Hist. t. 244*) a native of the Mediterranean, long misunderstood by botanists, and placed by the elder Agardh in *Zonaria*, to which its flabelliform fronds suggested a relationship. Its true characters were pointed out nearly about the same time by Decaisne and Zanardini, both of whom proposed it as the type of a new genus distinguished alike by external habit and by the curious tetrasporic fructification. Montagne, more recently, has described the sporiferous nucleus and thus completed the generic character. To this original species several have since been added, of which the two following are claimed for the North American flora.

1. PEYSSONNELIA *Dubyi*, Crouan; frond membranaceous, orbicular or lobed, attached by the whole of its under surface. Crouan, *Ann. Sc. Nat.* 1844, p. 368, t. 11, B. *Harv. Phyc. Brit.* t. 71. *J. Ag. Sp. Alg.* 2, p. 501. *Kütz. Sp. Alg.* p. 691.

HAB. On corals, &c. at Key West, *W. H. H.* (v. v.)

Fronds from half an inch to an inch in diameter, delicately membranaceous, orbicular or reniform, closely applied by the whole inferior surface to the object on which they grow, and to which they are attached by minute rootlets, freely emitted from the membrane. Upper surface finely striate, the striæ radiating from the centre to the circumference, composed of hexagonal, seriated cells. Margin circumscribed, flat. *Colour* toward the centre of the frond dark-red brown, paler and redder toward the margin. I have not seen fruit on the American specimens, which in other respects closely resemble those from the West of Ireland.

2. *PEYSSONNELIA imbricata*, Kütz. ; "depressed, adnate, red-black, coriaceous, irregularly sub-orbicular, lobed, imbricated, rugose, the lobes rounded." *Kütz. Sp. Alg. p.* 694.

HAB. Newfoundland, *Lenormand*, fide Kützing.

ORDER VIII. HELMINTHOCLADEÆ.

Helminthocladeæ, *J. Ag. Sp. Gen. and Ord. Alg.* 2, p. 410. *Part of Cryptonemeæ*, *J. Ag. Alg. Medit. p.* 81. *Harv. Man. Ed.* 2, p. 131.

DIAGNOSIS. Gelatinous, or gelatino-membranaceous, rosy or purple (cylindrical) sea-weeds, almost wholly composed of confervoid filaments set in loose gelatine. *Sporiferous-nucleus* immersed in the frond, destitute of pericarp, spherical, formed of branching spore-threads radiating from a central point, and bearing minute, roundish spores.

NATURAL CHARACTER. *Root* discoid, little developed. *Fronds* cylindrical or compressed, rarely somewhat flattened, dichotomous, pinnate, or shrub-like, sometimes very much branched, composed wholly or in great part of slender cylindrical or moniliform filaments variously combined together and lying in a transparent gelatine of greater or less consistence. The *axis* of the frond is in all cases formed of a bundle of longitudinal threads, interlaced together and frequently anastomosing, generally compactly united by a rather tenacious gelatine, and giving off, on the outside of the bundle, numerous horizontal filaments which terminate in those of

the periphery. These latter are generally moniliform, either elongated and free one from another, or abbreviated and combined by firm gelatine into a thin membrane. In the suborder *Liagoreæ* they are invested with a secretion of carbonate of lime.

The *sporiferous nucleus* is not contained within any conceptacle, but freely suspended among the threads of the peripheric stratum, by which it is surrounded and involucreted. It consists of a spherical ball composed of innumerable slender, articulated, branching filaments radiating from a common central point, and bearing small, oval *spores* on the ends of the branches. Such is the structure in the first suborder at least. In *Scinaia*, however, I think I have seen, under a highly magnifying power, a cellular membrane as described by Montagne, but denied by Prof. J. Agardh, investing the ball of spore-threads. *Tetraspores* have only been observed in *Nemalion*, where they are formed in the terminal cellules of the peripheric filaments.

The close mutual relationship of the genera here associated will be generally admitted; with perhaps the exception of *Scinaia*, should the fact of its possessing an external membrane to the nucleus be established. However this may be, the *internal* structure of its nucleus bears a near resemblance to that of the typical genera. The fructification of the *Liagoreæ* is not yet fully known, but the habit and nature of the frond are so similar to those of the *Gloiocladeæ* that there is nothing to invalidate the juxtaposition, at least, of these Algæ. *Dudresnaia*, *Crouania*, and *Gloiosiphonia*, which were formerly arranged among *Gloiocladeæ*, differ essentially in the structure of the sporiferous nucleus, and are now properly placed by Prof. Agardh, the two former in *Ceramiceæ*, the latter in *Cryptonemiaceæ*. In those Orders they represent, by analogy, the present group.

The geographical distribution of these plants is extensive. Of the five genera yet known four are North American; two of these, *Helminthora* and *Nemalion*, being also European; *Liagora* common to all tropical and sub-tropical regions; and *Scinaia* dispersed north and south of the equator through the Atlantic and Pacific basins. *Helminthocladia* has, as yet, only been found in Europe. None are applied in the arts.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

SUB-ORDER 1. GLOIOCLADEÆ. *Periphery* formed of moniliform filaments lying in rather loose, transparent gelatine.

- I. HELMINTHORA. *Axis* laxly cellular within (the interior filaments much distended). *Frond* decomponently much-branched.
- II. NEMALION. *Axis* cord-like, composed of closely interlaced, very slender filaments. *Frond* sparingly dichotomous.

SUB-ORDER 2. SCINAIEÆ. *Periphery* membranous, very thin, composed of angular cellules.

III. SCINAIA.

SUB-ORDER 3. LIAGOREÆ. *Periphery* formed of moniliform filaments, lying in gelatine and more or less invested with a deposit of carbonate of lime.

IV. LIAGORA.

I. HELMINTHORA. *J. Ag.*

Frond cylindrical, gelatinous, elastic, much branched, with a filamentous *axis* clothed with a continuous *periphery* of filaments, invested with a loose jelly; *axis* composed of concrete, parallel, longitudinal, articulated filaments of which the interior are of large diameter compared with the exterior; *periphery* of dichotomous moniliform, fastigate, horizontal filaments emitted laterally by those of the axis. *Sporiferous nuclei* immersed among the filaments of the periphery, spherical, composed of numerous clavate spore-threads, radiating from a central point. *Tetraspores* unknown.

This genus is proposed by Prof. Agardh for the *Dudresnaia divaricata* of authors whose want of accordance with *Dudresnaia* and affinity with *Nemalion* I had already indicated in the Phycologia Britannica. From *Nemalion* it differs in external habit, but chiefly by the structure of the axis, which is here composed of parallel filaments, concrete together, but not intertwined, and of different diameters, the inner ones being distended, and void of endochrome; the outer, from which those of the periphery are derived, of much greater tenuity and furnished with colouring matter.

1. HELMINTHORA *divaricata*, J. Ag.; frond filiform, pale red, very much branched, branches opposite or alternate, horizontal, decompound; ramuli numerous, divaricate, scattered, obtuse. *J. Ag. Sp. Alg. vol. 2, p. 416.* *Dudresnaia divaricata*, *J. Ag. Alg. Medit. p. 85.* *Harv. Phyc. Brit. t. 110.* *Nemalion divaricatum*, *Kütz. Sp. Alg. p. 713.*

HAB. Key West, *Dr. Blodgett* (No. 60). (v. v.)

Of this plant I have seen but a single American specimen, collected by Dr. Blodgett. It is about three inches long, rather thicker (in the dry state) than hog's bristle, with an undivided stem furnished with several lateral, horizontal branches

which are three or four times compounded, the divisions irregularly alternate, and spreading at right angles. The ramuli scattered, cylindrical and obtuse. *Peripheric* filaments irregularly branched, moniliform. *Nuclei* abundant.

Possibly this may be distinct from the European plant. The axial and peripheric filaments are rather more robust than in British specimens with which I have compared Dr. Blodgett's, but in other respects, internal and external, the two plants nearly coincide. The structure of the nuclei offers nothing peculiar.

1. NEMALION. *Duby.*

Frond cylindrical, gelatinous, elastic, dichotomous, with a cord-like axis clothed with a continuous periphery of filaments invested in gelatine; the *axis* composed of elongate, simple, longitudinal, interlaced filaments forming a medullary column, and surrounded by anastomosing threads from which issue the horizontal, dichotomous, fastigiate, moniliform filaments of the *periphery*. *Sporiferous-nuclei* immersed among the filaments of the periphery, spherical, composed of numerous clavate spore-threads radiating from a central point. *Tetraspores* "formed in the terminal cells of the peripheric filaments, triangularly divided, with prominent sporules." (*J. Ag.*)

The fronds are worm-like, either nearly simple or dichotomously branched, of a dull purple colour, and a highly elastic, gelatino-cartilaginous substance, shrinking very much in drying. A cross-section shows a very densely compacted medullary cord or axis composed of interwoven, twisted, slender, longitudinal filaments, giving off obliquely to all sides horizontal, dichotomously-divided branches which form the periphery. The evolution of the frond is thus described by Prof. J. Agardh:—"The different strata of the frond seem to me to be formed in an opposite direction. First, unless I am deceived, the peripheric stratum begins to be developed, from the base upward, by progressive evolution; some of the branches emitted by the peripheric filaments constitute the peripheric stratum, but others are erected, with a direction more vertical, giving off on their outer side new peripheric filaments, and on their inward side longitudinal filaments. These latter, at first, by an oblique course are directed towards the centre of the axis; then they take a downward direction, by a longitudinal course. In some respects, therefore, the mode of growth of the Endogenous stem is imitated. The filaments proceeding downwards are inarticulate and cylindrical; those growing upwards are articulated, and more or less contracted at the dissepiments. So that one may describe the stratification as threefold; a medullary stratum formed of longitudinal, simple filaments, an intermediate of obliquely horizontal, anastomosing filaments and a peripheric of horizontal, dichotomous, fastigiate filaments."

1. *NEMALION multifidum*, J. Ag. ; frond dichotomous, with rounded axils. *J. Ag. Sp. Alg. vol. 2, p. 419.* *Harv. Phyc. Brit. t. 36.* *Kütz. Sp. Alg. p. 712.* (Tab. XXIX. C.)

HAB. Bangor, Maine, *Mr. Hooper.* Newport, *Prof. Bailey.* Narragansett Pier, *Mr. Olney.* Providence, *Mr. Girard,* *Mr. Thurber.* Portland, *Capt. Pike.* Little Compton, *Mr. Geo. Hunt.* (v. v.)

Fronds six to ten inches long, as thick as crow's quills or thicker, worm-like, distantly forked, either regularly dichotomous or sub-palmate, the lesser branches frequently terminating in four or five finger-like lobes. *Axils* rounded. *Apices* very obtuse. *Substance* very elastic, firm. In drying, it shrinks very much, and closely adheres to paper. It is of a dull brownish purple colour.

Plate XXIX. C. *Fig. 1.* *NEMALION multifidum*, the *natural* size. *Fig. 2,* cross section of the frond ; *fig. 3,* peripheric filaments ; *fig. 4,* nucleus separated ; the latter figures *magnified.*

2. *NEMALION virens*, J. Ag. ; "frond compressed, gelatinous, horny when dry, short, repeatedly forked, by degrees attenuated." *J. Ag. Sp. Alg. vol. 2, p. 420.*

HAB. Pacific coasts of the Mexican Republic, *Liebman.*

"*Frond* as thick as a pigeon's quill, three inches long, below whitish with a yellowish tinge, green above ; when dry cartilaginous."

III. SCINAIA. *Bivona.*

(*Ginannia*, Montagne.)

Frond terete or compressed, dichotomous, gelatinoso-membranaceous, filled with fluid gelatine, traversed by a fibrous axis from which slender, dichotomous, horizontal filaments radiate towards the membranous periphery which is formed of a thin layer of roundish-angular cells. *Sporiferous nuclei* suspended within the membranous walls of the frond, spherical, (invested with a very thin membranous pericarp ?) composed of innumerable, branching, fastigiate, articulated spore-threads radiating from a central point, and bearing pyriform spores. *Tetraspores* unknown.

The frond in the typical species is rosy red, dichotomously branched and fasti-

giate, always regular in its ramification, but very variable in size and in substance. The widest specimens are always the most delicately membranaceous and gelatinous, the narrower ones being much firmer and of darker colour. The branches are bag-like, and filled with a half slimy, half watery gelatine, which may be squeezed from them, and which, being exuded in drying, causes the filmy remains of the plant to adhere very strongly to paper. The *axis* is composed of a densely interwoven rope-like bundle of very slender, longitudinal filaments, and is much more strongly developed in some specimens than in others; sometimes being reduced to a few threads, sometimes of considerable diameter, appearing in the dried plant like a strong midrib. A considerable space, filled with gelatine, intervenes between this axis and the membranous periphery, which is, however, organically connected with the axis throughout by innumerable obliquely-horizontal dichotomous filaments, or branches issuing from the axial threads, and terminating in the periphery. These constitute the *intermediate* stratum of the frond. The periphery is composed of one or two rows of roundish, coloured cellules, as it were the apices of the excurrent filaments of the axis, united together into a membrane.

The *sporiferous nuclei*, which are almost always to be found, are abundantly produced in all parts of the frond. They are suspended immediately within the membranous walls, or among the upper dichotomies of the excurrent, horizontal filaments. Professor Agardh describes them as naked, and as such I formerly figured them in *Phycologia Britannica*; but a recent examination, carefully made with a high magnifying power, favours the existence of a thin, membranous pericarp, composed of hexagonal cells, as described by Dr. Montagne. On removing some nuclei and pressing them gently between two pieces of glass, I repeatedly have seen a thin torn membrane among the dispersed sporethreads, and which most probably invested the ball. I have not, however, been able, by any other means, to obtain a view of it.

I follow Professor Agardh in adopting the name *Scinaia*, proposed, it would appear, so long ago as 1822, though overlooked until recently. I regret being obliged to lay aside that of *Ginannia*, under which the genus has been generally adopted, but the stringent laws of priority allow me no choice.

1. *SCINAIA furcellata*, Bivona; frond cylindrical, tender, uniformly dichotomous, fastigiate, equal or here and there constricted; apices obtuse. *J. Ag. Sp. Alg. vol. 2, p. 422.* *Ginannia furcellata*, Mont.—*Harv. Phyc. Brit. t. 69.* *Kütz. Sp. Alg. p. 715.* *Myelomium furcellatum*, Kütz. *Phyc. Gen. t. 73, f. 1.* *Ulva furcellata*, E. *Bot. t. 1881.*

HAB. Newport, Rhode Island, *Prof. Bailey.* Key West, *W. H. H.* (v. v.)

Frond two to four inches long or more, cylindrical, varying much in diameter, sometimes as thick as a swan's quill and sometimes not thicker than a sparrow's quill, many times forked, regularly dichotomous, level-topped, the branches when displayed having a definite, semicircular outline. Lower dichotomies sub-distant, upper successively closer together. *Axils* and *apices* blunt. *Substance* more or less

gelatinous. *Fructification* generally present. *Colour* a fine rosy or lake-red, becoming darker and browner in drying.

The largest of my Key West specimens is quarter of an inch in diameter, most of the others scarcely the tenth of an inch.

This species, first noticed on the east coast of England about fifty years ago, has been brought from very distant localities. It is found in Europe from the Baltic Sea to the shores of Spain, and in the Adriatic; in Africa at the Cape of Good Hope; in Tasmania and New Zealand; and on the coasts of Chili and of the Sandwich Islands.

IV. LIAGORA. *Lamour.*

Frond terete or compressed, dichotomous or pinnate, at length coated with a calcareous deposit, with a filamentous axis and continuous stratum of peripheric filaments; *axis* consisting of elongated, branching, interlaced, longitudinal filaments; *periphery* of horizontal, articulated, moniliform, much branched filaments. *Fructification* imperfectly known.

Under this genus are placed several Algæ of a gelatinous substance, formed of interlacing, longitudinal and horizontal confervoid filaments, and coated at maturity with a crust of carbonate of lime, organically deposited by the cellules of the frond. In consequence of this calcareous coating, Lamouroux placed the genus among the Tubularian Zoophytes; an association which could only be made on the most cursory observation of dried specimens. The elder Agardh therefore early restored the genus to the Florideous Algæ, to which group their colour indicates an affinity, while the structure of the frond is so very similar to that of *Helminthora* or *Nemalion*, that, even in ignorance of the fructification, we should be disposed to place them near those genera. The only other association which needs to be spoken of is that proposed by Decaisne, who refers *Liagora* to his *Batrachospermæ*. Against this arrangement the chief obstacle is that the *Batrachospermæ* are fresh water Algæ and of the Chlorospermatus division, while *Liagoræ* are marine and Rhodospermatus. It is true that some of them turn green in drying, but they also at the same time partially decompose, and we know that almost any red marine Algæ will in decay assume a green tinge. On the other hand *Thorea*, and even some species of *Batrachospermum* itself, become violet when dry. I have not seen fructification, which Prof. J. Agardh describes as "protruding beyond the calcareous crust; and composed of innumerable club-shaped, naked spore-threads radiating from a central point."

All the species are natives of the warmer parts of the sea, particularly of coral

reefs and islands. Of the described species four or five occur in the Mediterranean, and one extends along the Atlantic coast of Europe as far north as Brest, the highest latitude attained by the genus. Probably many remain to be described, but require careful attention in a living state for their correct determination, as all change considerably, and some can scarcely be recognized in a dried state. Several reputed *Galaxauræ* of the section *Microthoe*, perhaps all the species of that section, appear to me to belong to *Liagora*, but I have not had good opportunities of examining them.

* *Fronds covered with a continuous calcareous deposit.*

1. *LIAGORA valida* ; frond robust, repeatedly dichotomous, fastigiate, with rounded axils, becoming when dry whitish with red-brown apices, covered with a thin continuous, calcareous deposit ; apices obtuse, not attenuated ; filaments of the periphery repeatedly forked, fastigiate, moniliform, their cells elliptical. (TAB. XXXI. A.)

HAB. Sand Key, Florida, *W.H.H.* (v. v.)

Fronds tufted, two to three inches long, half a line in diameter, terete when fresh, becoming compressed in drying, repeatedly and nearly regularly dichotomous from the base, the axils rounded, the apices obtuse and divaricating, not at all attenuate. *Calcareous* coat thin, but uniformly spread, completely coating the peripheric filaments in the lower part of the frond, less dense near the ends of the branches, allowing the tips to project beyond it. When dry, the coated portion of the frond assumes a chalky whiteness. On removing the lime by acid, the peripheric stratum resembles that of *Helminthora*. The peripheric filaments are three or four times divided, the articulations of equal diameter throughout, the lower ones sub-cylindrical, the upper successively more elliptical and contracted at the dissepiments. The colour when recent is a pale pinky red, which is partially retained in the microscopic view of the re-moistened plant.

This may have been previously described as a *Galaxaura* of the section *Microthoe*, but I am not possessed of materials sufficient to decide the point.

Plate XXXI. A. *Fig. 1.* *LIAGORA VALIDA*, the *natural* size. *Fig. 2*, portion of a branch from which the lime has been removed ; *fig. 3*, axial and peripheric filaments ; *fig. 4*, a peripheric filament ; *fig. 5*, apex of the same ; the latter figures more or less *magnified*.

2. *LIAGORA pinnata* ; stem sub-simple, closely set throughout with lateral branches, which spread toward every side ; branches pinnate, or sub-bipinnate, the pinnæ frequently opposite, the pinnules irregularly placed, cylindrical, obtuse, spreading ; calcareous deposit thin, continuous ; apices reddish-brown when dry ; filaments of the periphery not much branched, irregularly dichotomous, fastigiate, not beaded, their cells about twice as long as broad, cylindrical. (TAB. XXXI. B.)

HAB. Sand Key, Florida, *W. H. H.* (v. v.)

*Fron*d about three inches long, about as thick as sparrow's quill, with a leading stem set at short intervals with branches an inch or two in length, spreading to all sides, the lowest short, the middle ones longest, the rest shorter upwards. *Branches* mostly pinnated, sometimes forking or sub-bipinnated, the larger ones occasionally more compound, all the divisions very patent. *Ramuli* opposite or alternate, cylindrical, obtuse. When dry, the frond, as usual, becomes compressed and loses colour; the older and more coated parts turn white, the younger change to a dark reddish brown; under the microscope exactly a "pepper and salt," or mottled with specks of white and brown. The peripheric threads are simpler, less regularly forked, and more cylindrical than in the preceding species, their cells being scarcely constricted at the ends. *Colour* when growing, a pale pinky red. *Substance* cartilagineo-gelatinous. In drying, it closely adheres to paper.

Plate XXXI. B. Fig. 1. *LIAGORA pinnata*; the *natural* size. Fig. 2, part of a branch; fig. 3, peripheric and axial filaments; fig. 4, a peripheric filament; fig. 5, apex of the same; all more or less *magnified*.

3. *LIAGORA ceranoides*, Lamour.; "frond compressed, canaliculate at one side from the base to the apex, dichotomously branched, fastigate, clothed with a continuous crust, apices forked, sub-diverging, the younger ones purplish red." *J. Ag. Sp. Alg.*, vol. 2, p. 426.

HAB. Vera Cruz, *Liebman*.

It must be borne in mind that the above description has been made from dried specimens, and the *compressed, canaliculate frond* may refer only to the dried plant. I am not acquainted with this species, which is said to agree with *L. viscida* in size and ramification.

* * *Fron*ds covered with a powdery calcareous deposit.

4. *LIAGORA leprosa*, J. Ag.; frond terete, (compressed when dry) repeatedly dichotomous, fastigate, with rounded axils, covered with a pulverulent calcareous deposit, whitish when dry, with the ends of the branches greenish; filaments of the periphery flabelliform in outline, excessively di-trichotomous, moniliform, the ultimate cellules very minute. *J. Ag. Sp. Alg.* 2, p. 427. *Kütz. Sp. Alg.*, p. 539. (TAB. XXXI. C.)

HAB. Vera Cruz, *Liebman*. Sand Key, *W. H. H.* (v. v.)

*Fron*d tufted, one to two inches high, as thick as sparrow's quill, terete when recent, compressed or channelled at one side when dry, repeatedly and very regu-

larly dichotomous from about an inch above the base, without lateral branches; the segments fastigate, sub-corymbose. *Axils* all very obtuse. *Apices* blunt, rounded or emarginate in the dried specimen. On removing the calcareous matter with muriatic acid, the axis is seen to be composed of many very slender, cobwebby, hyaline, long-jointed, cylindrical filaments, from which issue laterally toward the outside the horizontal peripheric filaments whose apices constitute the continuous surface of the frond. These are pedicellate or unbranched for a third of their length, then forked, and afterwards excessively di-trichotomous, all the branches fastigate, composed of elliptical or globose cells, strung together like the beads of a necklace; the ultimate cellules exceedingly minute, and appearing dot-like even under a high magnifying power. *Colour* when growing a pale pinky red, soon changing on exposure, and fading altogether during the process of drying. The dried plant is coated with a powdery, calcareous deposit, and white, except the ends of the branches, which become green. The substance is soft, between gelatinous and cartilaginous, and the plant rapidly decomposes. In drying, it adheres closely to paper.

I should not have ventured to refer my specimens as above, had I not received a specimen of Professor Agardh's plant from that author himself, and found it to agree with my Sand Key specimens in every particular. The differences in our descriptions arise from his having seen and examined dried specimens only.

Plate XXXI. C. *Fig. 1*, tuft of *LIAGORA leprosa*, the natural size. *Fig. 2*, portion of a branch; *fig. 3*, axial and peripheric filaments from the same; *fig. 4*, part of one of the lesser branches of a peripheric filament; *fig. 5*, apex of a division of the same; the latter figures more or less highly magnified.

5. *LIAGORA pulverulenta*, Ag.; "frond compressed, sub-canaliculate, terete above, dichotomous, with many lateral proliferous branches, covered with a powdery crust; the apices divaricate, obtuse; the younger ones purpurascent." *J. Ag. Sp. Alg. vol. 2, p. 427. Kütz. Sp. Alg. p. 538.*

HAB. Vera Cruz, *Liebman*.

I am not acquainted with this species.

ORDER IX. WRANGELIACEÆ.

Wrangelia, J. Ag. Sp. Gen. Ord. Alg. vol. 2, p. 701. Part of *Ceramiaceæ*, J. Ag. Alg. Medit. p. 69. Endl. 3d. Suppl. p. 34. Harv. Man. Ed. 2, p. 156. Part of *Callithamniæ*, Kütz. Sp. Alg. p. 664.

DIAGNOSIS. Rose-red, filiform, articulate or inarticulate sea-weeds, furnished with a monosiphonous, articulated axis. *Sporiferous-nucleus* naked, formed of branching spore-threads radiating from a fixed point, or whorled round minute lateral ramuli. *Spores* pear-shaped, formed in the terminal cell of the spore-thread.

NATURAL CHARACTER. *Root* a small disc. *Fronds* filiform, much branched, alternately decompound or decompound-pinnate, the branches either opposite or alternate, articulate or inarticulate, the inarticulate species traversed by an articulated, monosiphonous axis, round which smaller stratified cellules are gradually deposited. The younger portions of the frond in the typical genus are always confervoid, or composed of a single row of cellules placed end to end in an articulated thread. The cell-walls are thick, pellucid, and of a softish substance, soon decomposing in fresh water. The endochrome, when recent, is generally a brilliant rosy red or purple-lake tint, which is sometimes partially preserved in drying, but frequently it becomes browner in drying, and in several species changes to a dark brown or even black. This a good deal depends on the state of individual specimens, as the shade of colour varies in the same species.

The *sporiferous nucleus* is not enclosed within any conceptacle, nor is it immersed in the frond, but exposed wholly naked, or at most surrounded with involucrial ramuli, which close over it without contact. It consists of many branching spore-threads, either springing in a globose cluster from the end of a shortened branch, or whorled round the middle portion of minute, lateral ramuli. These spore-threads at maturity bear on the branches solitary, pear-shaped spores, formed by a transmutation of the terminal cells. The *tetraspores* are only known in some species of *Wrangelia*. They, also, are naked, scattered along the monosiphonous, confervoid ramuli, each tetraspore being formed of a ramulus shortened to a single cell.

At present this Order consists of two genera, one removed from the *Ceramiaceæ*, the other from the *Gloiocladeæ*. In the structure of the frond and in the whole external habit, *Wrangelia* so perfectly resembles a Ceramiaceous plant that some of its species have been, at different times, referred either to *Griffithsia* or to *Callithamnion*, and so far as structure may indicate affinity there is a near agreement between *Callithamnion* and *Wrangelia*. But here the relationship ends, for the nature of the

sporiferous nucleus in these genera is widely different. In *Callithamnion* the nucleus is a naked *favella* or encysted cell filled with a mass of disconnected spores originating in the repeated division of the endochrome of the mother cell; in *Wrangelia*, as already described, it is a tuft of spore-threads bearing pear-shaped pedicellated spores. If therefore the structure of the nuclei is to be our guide in arrangement, the resemblance of *Wrangelia* to *Callithamnion* is one of analogy only, these genera representing each other in the series to which they respectively belong.

Naccaria, which is associated with *Wrangelia* by Prof. J. Agardh, appears at first sight to have little affinity with it, differing especially in the wholly inarticulate frond. This character is, however, of minor importance, as is seen in *Ceramiceæ*, where some genera are inarticulate; or even in *Wrangelia* itself, where the older portions of the stem and branches in several species are opaque. A comparison of the sporiferous threads of *Naccaria* with those of *Wrangelia* will show an agreement in essential structure; and the differences in the nuclei are chiefly in the arrangement of the parts, the spore-threads of *Wrangelia* radiating from the end of a truncated branch, those of *Naccaria* being whorled round the ramuli. I think, therefore, a true relationship between these genera has been established.

WRANGELIA. Ag.

Frond filiform, decompound-pinnate, articulated, one-tubed; the *internodes* naked or coated with minute cellules, the *nodes* clothed with opposite or whorled, byssoid, articulated ramelli. *Sporiferous-nucleus* terminal, involucred, the involucre formed of byssoid ramelli, the nucleus composed of a dense tuft of radiating pyriform spores, formed of the terminal cells of the spore-threads. *Tetraspores* naked, sessile on the sides of the ramuli, spherical, triangularly divided.

In some species the frond is pellucidly articulate throughout, each internode formed of a single, cylindrical, thick-walled cell, filled with a brilliant carmine endochrome, and separated from the internodes above and below it by a hyaline diaphragm. In others the younger parts of the frond alone exhibit this perfectly articulated structure; the older portions being more or less fully coated with a stratum of small cellules; and in some other species the whole of the stem and branches are rendered opaque by these accessory cells, and the articulated structure of their fronds can only be ascertained by a careful dissection. In all the species the ultimate ramelli, which are often of a byssoid tenuity, are single-tubed and pellucidly articulate, and they generally spring from each node throughout the frond. They are minute, pinnately or dichotomously compounded, mostly whorled, but sometimes distichous, and, in that case opposite each other. It frequently

happens that the ramelli are longer at one side of the stem than at the other, the long and short filaments alternating from node to node.

The *sporiferous-nucleus* generally terminates a short branch. It is destitute of any proper coating or pericarp, but is surrounded and often closely invested by a whorl of byssoid ramelli. It consists of a tuft of spore-threads, radiating from the apex of the branch, and bearing terminal, pear-shaped spores. The *tetraspores* are scattered along the ramelli, of whose metamorphosed branches they are formed; they are spherical or ellipsoidal, sessile, and triangularly divided.

Of this genus, which was originally founded on our *W. penicillata*, several species are now known, dispersed through the Atlantic and Southern Oceans. Some of them have the external habit of *Griffithsia*, others of *Callithamnion*, and others of *Dasya*, genera to which, in their fructification, they have but little affinity. In the nature and position of the tetraspores, indeed, there is a close resemblance between *Wrangelia* and *Callithamnion*; but the structure of the sporiferous-nucleus obliges us to place them widely apart. From *Dasya* the monosiphonous frond affords an easily-seen distinction, independently of fructification.

1. *WRANGELIA penicillata*, Ag.; frond ultra-setaceous, decompound-pinnate, distichous, the stem and larger branches corticate, opaque, the lesser branches articulate; ramelli whorled round the nodes, repeatedly dichotomous, of nearly equal diameter throughout, obtuse, their articulations contracted at the dissepiments, 4—8 times as long as broad. *J. Ag. Sp. Alg.* 2, p. 708. *Kütz. Sp. Alg.* p. 664. (TAB. XXXIV. B.)

HAB. Key West, very abundant. *W. H. H., Dr. Blodgett, Prof. Tuomey, &c.* (v v.)

A most variable plant in aspect, according to the greater or less development of the primary and secondary branches; but when this is borne in mind, easily recognisable under all its forms. The branching is uniformly distichous, and decompound-pinnate. Sometimes it is nearly simply pinnate, with few and distant pinnae; sometimes a few alternate long branches, or primary pinnae, are set with minute alternate pinnules 2 or 3 lines long; sometimes the frond is closely and regularly thrice or four times pinnated, each branch having an ovate or lanceolate outline and fern-like aspect; and between these extreme forms there are endless varieties. In all cases the branches are whorled at every node with very soft, repeatedly dichotomous, confervoid filaments, which are very frequently longer at one side of the branch than at the other. The articulations of these ramelli are 4 to 6 or 8 times as long as broad, swollen upwards, the dissepiments much contracted, and the terminal cell obtuse. The stem and larger branches are coated with small cellules, and thus appear opaque and inarticulate; in the smaller branches the cellular coat is less uniformly spread, and the ultimate or youngest branches are pellucidly articulate. The *sporiferous nucleus* is globose, and usually terminates the shorter branches. It is surrounded by an involucre composed of copious

ramelli, which often overtop it, and completely hide it. *Antheridia* frequently occupy the position of tetraspores. They consist of minute spherical tufts of dichotomous, radiating filaments attached to the sides of the ramelli. I have not found *tetraspores* on the American specimens. When quite fresh the frond is of a beautiful rosy red, and sometimes this is partially preserved in drying; but more commonly, especially if the specimen be suffered slightly to decay, it turns dark brown or blackish in the drying process, and stains the paper of the same colour. The *substance* is very flaccid and tender, soon decaying in fresh water.

I was at first disposed to regard our American plant as distinct from the European *W. penicillata*, and had proposed to call it *W. filicina*, but a careful comparison of numerous specimens has shown that the distinctions on which I had relied are insufficient.

Plate XXXIV. B. *Fig.* 1 and 2, different varieties of *WRANGELIA penicillata*, the natural size. *Fig.* 3, one of the smaller branches, with its whorled ramuli; *fig.* 4, a small portion of the stem or of a large branch; *fig.* 5, cross section of the same; *fig.* 6, a fertile branch, with terminal involucre and nucleus; *fig.* 7. nucleus (not quite correctly drawn); *fig.* 8, *spores* from the same; *fig.* 9, vertical view of a whorl of ramuli, to shew the excentric position of the branch: the latter figures more or less *magnified*.

2. *WRANGELIA plebeia*, J. Ag.; "fronds corticate, sub-pinnately branched, and verticillately ramellose at the nodes, penicillate at the apex; ramelli repeatedly dichotomous, the terminal cells acute, articulations of the ramelli contracted at the dissepiments, 4—5 times as long as broad." *J. Ag. Sp. Alg. vol. 2, p. 708.*

HAB. At Vera Cruz, Mexico, *Liebman*.

Probably, as Professor Agardh suggests, only a variety of the preceding species.

ORDER X. RHODYMENIACEÆ.

Rhodymenia, J. Ag. *Sp. Gen. and Ord. Algarum*, p. 373. *Part of Rhodymeniaceæ*, Harv. *Man. Ed. 2, p. 120.* *Part of Sphærococcoideæ and Delesseriaceæ*, Auct. &c.

DIAGNOSIS Purplish or blood-red sea-weeds, with an inarticulate, (flat, compressed or filiform) membranaceous frond, composed chiefly of polygonal cells; the surface cells forming a continuous coating. *Nucleus* lodged in an external *conceptacle*, simple or formed of several nucleoli. *Spores* at first associated in moni-

liform, branching strings issuing from a placenta, at length massed together without order.

NATURAL CHARACTER. *Root* mostly a mere disc, sometimes, as in *Plocamium*, branching. *Frond* membranaceous in substance, very variable in general habit and branching. Most commonly the membrane is flat, narrow, or expanding into broad dichotomously or irregularly cleft expansions, without trace of midrib or veins. In one genus only (*Wormskioldia*) nerved leaves, of definite form and delicately membranous areolated substance, occur. In *Plocamium* the frond is linear, often very narrow, much branched in a pinnate order, flat or compressed, with or without midrib. In *Rhabdonia* it is terete, the exterior strata composed of the ordinary polygonal cells, the axis of closely interwoven cylindrical cells disposed in filaments.

The sporiferous *nuclei* are always lodged in proper conceptacles, external or partly immersed, usually hemispherical and destitute of apical pore, sometimes opening at the apex, or even furnished with a prominent orifice. These conceptacles are either marginal or scattered over the surface, or (rarely) formed in proper leaf-like processes. Within a densely cellular pericarp, a basal or central placenta is often largely developed; from it issue toward all sides dense tufts of branching spore-threads, either united in a single nucleus or divided into several, which are sometimes separated by barren filaments running from the placenta to the pericarp. The sporiferous threads are moniliform, branched, articulated, each articulation containing at an early stage a simple mass of endochrome, but by repeated cell-division the contents of each cell is finally converted into a cluster of *spores*, held together by the dilated cell-wall. The clusters thus originated, being confined within the narrow cavity of the conceptacle, are closely pressed together and at length massed into nuclei or nucleoli without obvious order. The spores, also by reason of pressure, become irregularly angular or wedge-shaped. The *tetra-spores* are roundish or oblong, and variously parted; and are either dispersed among the surface cells, or collected in definite sori, or lodged in proper leaflets.

This order has recently been proposed by Professor J. G. Agardh to include a few genera which, on account of the very different structure of their conceptacular fruit, he has rejected from the *Sphærococcoideæ*; a measure rendered necessary by the new principles of arrangement developed by that author. These plants, however, so closely resemble the genuine *Sphærococcoideæ* in external habit, and even in the internal structure of the stem and leaves, that recourse must sometimes be had to an accurate microscopic analysis of the contents of the conceptacle, before the student can ascertain the proper place in the system of the plant under examination. This is notably the case in the genera *Wormskioldia* (founded on *Delesseria sanguinea*, Ag.) and *Delesseria* (*D. sinuosa*, &c.), two genera with fronds of precisely similar texture and appearance, but with a fructification of a structure so different that we are compelled to place them not only in different Orders, but in different Series. If this seems an unnatural distribution, as it certainly is contrary to long established prejudice, let it be remembered that there are species of *Cactus*, *Stapelia*, and *Euphorbia* equally resembling each other in habit,

but equally differing in fructification; and that in every natural arrangement characters derived from the structure of the fructification are to be preferred to all others.

All the genera of this Order are widely dispersed. *Rhodymenia* has species in the Arctic and Antarctic Oceans, as well as in the temperate and tropical zones. *Euthora* and *Rhodophyllis* characterise high northern and high southern latitudes. One species of *Plocamium* is cosmopolitan, while the rest, fourteen in number, are confined to the southern hemisphere. *Rhabdonia*, the only remaining genus, has tropical and Australian species.

Among the useful plants the most remarkable is *Rhodymenia palmata*, the Dulse or Dillisk of the Irish (*see* INTROD. Part 1, p. 33); and among the most beautiful are *Euthora cristata*, *Wormskioldia sanguinea*, and the various species of *Plocamium*,—all highly prized by collectors of “Ocean flowers.”

SYNOPSIS OF THE NORTH AMERICAN GENERA.

* *Frond flat, dichotomous or irregularly laciniate or multifid.*

† *Sporiferous nucleus simple, surrounded by a gelatinous integument.*

I. RHODYMENIA. *Frond* stipitate, leaf-like, dichotomous or palmate.

†† *Sporiferous nucleus compound, formed of several nucleoli more or less confluent.*

II. EUTHORA. *Frond* dichotomo-pinnate or laciniate, often very narrow. *Tetraspores* cruciate.

III. RHODOPHYLLIS. *Frond* dichotomous, often fringed with marginal lobes. *Tetraspores* zonate,

** *Frond linear, plano-compressed, pectinato-pinnate, the ramuli alternately secund in threes or fours.*

IV. PLOCAMIUM. *Tetraspores* zonate, contained in marginal spore-leaves.

*** *Frond terete, alternately decomposed.*

V. RHABDONIA. *Conceptacles* half immersed in the branches. *Tetraspores* zonate, dispersed through the superficial cells.

VI. CORDYLECLADIA. *Conceptacles* external, sessile. *Tetraspores* cruciate, lodged in proper, pod-like ramuli.

I. RHODYMENIA. *Grev.*

Frond flat, membranaceous, dichotomous or palmate, often proliferous from the margin or disc, composed of two strata of cells; the inner cells oblong, the superficial minute, in few vertical rows. *Conceptacles* scattered over the frond, sessile, hemispherical, with a cellular pericarp at length opening by a terminal pore; *sporiferous filaments* very numerous, emitted from a *basal* placenta, and forming a simple nucleus surrounded by a gelatinous pellicle. *Tetraspores* either collected in cloud-like patches, or dispersed over the frond among the superficial cellules, roundish, cruciate or tripartite.

This genus, as originally constituted, included a large number of plants which had a resemblance in habit to each other, but which a more accurate examination has shown to belong to several widely separated types of structure: hence the genera *Euthora*, *Rhodophyllis*, *Kallymenia*, *Callophyllis*, *Calliblepharis*, *Sarcodia*, &c., have been formed at its expence. The generic character, as here given, is that fixed by Prof. J. G. Agardh. It reduces the species now placed in *Rhodymenia* to about a dozen at the most; and, small as this number is, they naturally divide into two sections or sub-genera, distinguished not less by peculiarities of fructification than by minor external characters. In the first section the tetraspores are scattered through the surface cellules over the whole frond; the fronds are of large size, purplish or dull-red, sub-simple or irregularly palmatifid, and the stem is but little developed. In the second the tetraspores are confined to definite sori, placed immediately below the ends of the lobes; the fronds are dichotomous, of a bright red or rosy, and the stem is always considerable, and sometimes branched. The species of this latter section have a habit very similar to that of *Phyllophora*.

1. *Palmatæ*: *tetraspores* scattered in cloudy patches over the whole frond.

1. RHODYMENIA *pertusa*, J. Ag.; stipes short, cartilaginous, compressed, expanding into a broadly lanceolate, sub-undivided, membranaceous, blood-red lamina (one to three feet in length) attenuated at the base; conceptacles very numerous, densely scattered over the surface of the frond. *J. Ag. Sp. Alg.* 2, p. 376. *Rhodymenia Wilkesii*, Bail. and Harv. in *Bot. Expl. Ex. cum Icone*, ined. *Porphyra pertusa*, Post. and Rup. *Alg. Ross.* p. 20, t. 36.

HAB. Straits of St. Juan de Fuca, *Capt. Wilkes.* (v. s.) Greenland, *Wormskiöld.*

Root scutate. *Fronds* tufted, rising with a compressed stem, which, at half an inch to an inch from the base becomes flattened, cuneate, and gradually widens, until it passes into the base of a broadly lanceolate lamina, from one to three feet long, and from four to eight or ten inches wide. *Lamina* much attenuated at the base, commonly quite simple, sometimes forked; the newer portions formed, as in *Laminaria*, between the apex of the cartilaginous stem and the base of the expansion. *Colour* pale blood-red, fading into greenish. *Conceptacles* as large as poppy-seed, spherical, extremely numerous, half immersed in the lamina and scattered thickly through three-fourths of it, commencing at the apex and extending toward the base.

This fine species was originally published under the erroneous generic name of *Porphyra*; and as such it escaped the notice of Prof. Bailey and myself when, in examining the Algæ of Wilkes' Exploring Expedition, we proposed to give Capt. Wilkes's name to what we rightly considered a *Rhodymenia*, and believed to be an unpublished species. Meantime, Professor Agardh having received specimens of the so-called *Porphyra pertusa*, and at once perceiving that they were referable to *Rhodymenia*, has sanctioned the specific name *pertusa* in his recently published Species Algarum. I am therefore constrained to adopt this name, in preference to that which my friend Bailey and I had proposed. It is given by its author in allusion to certain roundish holes often to be found in the membranes, but which appear to me to be casualties, such as occur in very many of the membranous Algæ, as in *Ulva latissima*, &c. I have received from Dr. Ruprecht an authentic specimen of his plant, and find it identical in species with the specimens brought home by Wilkes. These latter are, however, of much greater size and in more perfect condition.

2. *RHODYMENIA palmata*, Grev.; frond coriaceous or membranaceous, purple, broadly wedge-shaped, irregularly cleft, palmate or dichotomous, sometimes repeatedly lacinate; the margin flat and even, sometimes winged with leaflets; tetraspores distributed over the whole frond in cloud-like spots. *Harv. Phyc. Brit. t.* 217 and 218. *J. Ag. Sp. Alg. 2, p.* 376. *Sphærococcus palmatus*, Kütz. *Sp. Alg. p.* 781. *Fucus palmatus*. Lin.—Turn. *Hist. Fuc. t.* 115. *E. Bot. t.* 1306. *Dulse* or *Dillisk*, *vulg.*

HAB. Parasitical on littoral *Fuci*, *Laminariæ*, etc. Halifax, W. H. H. Boston Bay, Dr. Asa Gray, Mr. G. B. Emerson, etc. Long Island Sound, Prof. Bailey, Mr. Hooper, etc. Common. (v. v.)

Frond 6—12 inches long or more, from one to four or six inches broad, cuneate at the base, and generally broadly cuneate in outline, vertically cleft in a sub-palmate manner; sometimes quite simple, sometimes cloven nearly to the base into innumerable slender ribbons. The margin is generally flat, but is often furnished at intervals with simple or forked leaf-like lobes, giving a pinnate character to the frond. *Apices* obtuse. *Axils* generally acute. *Substance* firmly membranous or

leathery, not adhering to paper except after a long maceration in fresh water. *Colour* a deep brownish purple.

In some specimens dredged in Halifax Harbour the frond is very much broader than its length, but little divided, and having the margin very much waved. The substance is thinner than in the common form, which occurs abundantly at Halifax.

3. RHODYMENIA? *interrupta*, Grev. ; frond membranaceous, irregularly divided, sub-dichotomous ; the laciniae divaricated, linear, constricted at short intervals ; the terminal lobes digitate ; axils and apices rounded. *Grev. in Nov. Act. Nat. Cur. xiv. p. 423, t. xxvi. fig. 1. J. Ag. Sp. Alg. 2, p. 382.*

HAB. Arctic Sea, *Lieut. W. N. Griffiths.* (v. s. in Herb. Cl. Dnæ. Griffiths.)

Base unknown. *Frond* (broken) eight or ten inches long, irregularly dichotomous, the terminal lobes digitate or pedate. *Laciniae* widely spreading or divaricate, about half an inch wide, linear, repeatedly but irregularly constricted at short intervals in a nodose manner ; the margin undulate. *Axils* very obtuse, rounded, from half an inch to an inch wide. *Apices* rounded, somewhat wider than the laciniae. *Nemathecia* wart-like, small, clustered, growing from the margin or the disc of the lower segments. *Substance* thin. *Colour* a dull red, rather brownish below. It does not adhere to paper.

A thin slice shows two or three rows of large, polygonal, empty medullary cells, with a thin exterior coating of coloured, minute cells, gradually smaller towards the circumference. This structure is different from that of *Phyllophora Brodiaei*; to an extravagant form of which variable plant this curious species bears some resemblance. I have to express my thanks to Mrs. Griffiths for allowing me to examine the single specimen brought home by her son from the Arctic regions, being that from which Dr. Greville's figure was made, and the only one known to exist at present in any Herbarium.

2. *Palmettae*: tetraspores aggregated in distinct sori below the tips of the laciniae.

4. RHODYMENIA *Palmetta*, Grev. ; stipes cylindrical, sub-simple, expanding into a fan-shaped, rose-red frond, more or less deeply cleft dichotomously ; laciniae linear-wedge-shaped, with broad rounded interstices and a very entire, flat margin ; apices either erose or rounded ; conceptacles marginal or scattered ; tetraspores cruciate, forming deep-red sori in the dilated apices. *Harv. Phyc. Brit. t. 134. J. Ag. Sp. Alg. 2, p. 378. Sphaerococcus Palmetta, Kütz. Sp. Alg. p. 782. Fucus Palmetta, Esper. t. 40. Turn. Hist. t. 73. E. Bot. t. 1120.*

HAB. On shells and stones in deep water and on the stems of Laminariæ. Halifax, *W. H. H.* (v. v.)

As yet my only authority for claiming American Citizenship for this plant, is a single fragment picked up at Halifax. It is about an inch and half high, and three-forked at half an inch from the base, the lobes linear, cuneate, dichotomous, spreading; the outline fan-shaped; the ultimate lobes slender. One or two imperfectly developed conceptacles are sessile on the ultimate laciniaë, about the middle. It is to be hoped that some more fortunate collector may obtain satisfactory specimens.

II. EUTHORA. J. Ag.

Fronde membranaceous, flat, dichotomo-pinnate, composed of two strata of cells; those of the inner stratum, oblong, large; of the outer, coloured, minute, in few rows. *Conceptacles* marginal, sub-spherical, with a closed cellular pericarp (composed of concentric layers of cellules at one point radiating); *sporiferous filaments* very numerous, radiating from a *central* placenta, which is suspended in the cavity of the pericarp by sub-simple filaments; the fertile spore-threads forming roundish masses of *spores* from their upper cells. *Tetraspores* cruciate, lodged in the thickened apices of the frond.

Separated from *Rhodymenia*, where it had been placed by Greville, by Professor Agardh, on account of the different structure of the conceptacles, a character no doubt of grave importance, although difficult to be seen without a careful dissection; and this is difficult to accomplish, owing to the minuteness of the object to be cut through. In *Rhodymenia* the placenta projects from the *base* of the cell, and throws up from its upper surface masses of spore-threads, which finally unite into a single globose nucleus; in *Euthora* the placenta is in the *centre* of the cavity, where it is suspended by cord-like filaments drawn from it to the surrounding walls, and the spore-threads issue from it on every side. This is the essential distinction. Another character is noticed by Prof. Agardh in the structure of the walls of the pericarp, which in *Euthora* are composed of several sub-concentric layers of cells, except at one spot, where the cells are set in lines radiating, like the spokes of a wheel, from the nucleus outwards, and indicating probably, as Prof. Agardh suggests, the point where the wall first gives way to permit the escape of the spores.

1. *EUTHORA cristata*, J. Ag.; frond fan-shaped, membranaceous, sub-dichotomous or somewhat pinnately-multifid, the segments dilated upwards and repeatedly subdivided; lesser divisions alternate, linear, laciniate at the ends, and often fimbriate

at the margin ; conceptacles spherical, marginal ; tetraspores contained in the thickened tips of the laciniae. *J. Ag. Sp. Alg.* 2, p. 385. *Rhodymenia cristata*, Grev.—*Harv. Phyc. Brit.* t. 307. *Callophyllis cristata*, Kütz. *Sp. Alg.* p. 747. *Fucus cristatus*, L.—*Turn. Hist.* t. 23.

HAB. Arctic coast, *Lieut. W. N. Griffiths*, *R. N.* Abundant from Halifax (*W. H. H.*) to Cape Cod, many varieties, *Mrs. Asa Gray*, *Mrs. Mudge*, *Dr. Durkee*, &c. (v. v.)

Fronde one to three inches high, distichous, excessively branched, more or less fastigiate, flabelliform, the expansion of the branches equal to the length of the frond. *Branches* linear, varying in breadth from the diameter of a hog's bristle to one or two lines or more, sub-dichotomously, palmately, or alternately decompound, the divisions successively narrowed. Sometimes the whole frond is sub-dichotomous and nearly equally narrow ; sometimes decompound-pinnate, and sometimes a few broad, pinnatifid laciniae are bordered by finely-cut ramuli. The frond is not perfectly flat, when narrow, but two edged, slightly convex in the centre. *Conceptacles* abundant, spherical, marginal, as large as poppy seed, dark coloured. *Tetraspores* cruciate, thickly congregated in the thickened and dark coloured tips of the laciniae. *Colour* a beautiful crimson lake, becoming scarlet on steeping in fresh water*. *Substance* somewhat cartilaginous. It shrinks in drying, and but imperfectly adheres to paper.

Most of my Halifax specimens are of the narrow varieties, some so narrow and multifid as closely to resemble the smaller and slenderer forms of *Plocamium coccineum*. In Boston Bay, where the plant occurs in great profusion and beauty, broad and narrow varieties are nearly equally common. The geographic range of this species is alluded to in our *Introd.* p. 23.

III. RHODOPHYLLIS. Kütz.

Fronde flat, membranaceous, dichotomously cleft, often with marginal lobes, composed of two strata of cells: cells polygonal, those of the medullary stratum larger, longitudinal ; of the outer, vertical, in few rows. *Conceptacles* mostly marginal, sub-spherical, with a closed pericarp (composed externally of radiating, internally of concentrically arranged cellules) ; sporiferous filaments very numerous, radiating from a basal placenta ; the fertile ones forming roundish masses of spores from the uppermost cells. *Tetraspores* zonate, immersed in the frond or in its marginal lobes.

A small genus typified by *Rhodymenia bifida*, Grev. (*Fucus bifidus*, Turn.), and

now including four species, three of which are natives of the northern and one of the southern hemisphere. It differs from the restricted genus *Rhodymenia* partly by the structure of the nucleus, and partly by the zonate tetraspores. The generic name here adopted was proposed in 1847 by Kützinger, who probably overlooked the name *Wigghia* which I suggested (*Phyc. Brit. t. 32*) some few months earlier. Hoping to find some future opportunity of honouring the memory of Mr. Lilly Wigg, I cheerfully acquiesce in the change.

1. RHODOPHYLLIS *Veprecula*, J. Ag.; "frond dichotomo-decompound, and pinnated at the margin; pinnæ lanceolate or linear, ciliate; cilia subulate, short or the longer ones forked; conceptacles densely clustered at the base of the cilia, often confluent; tetraspores numerous, lodged in the cilia." *J. Ag. Sp. Alg.* 2, p. 390. (*excl. Syn. Beechey.*)

HAB. Greenland, *Agardh*.

"Two to three inches high; the segments sometimes scarcely a line, sometimes three or four lines broad, ciliate, the cilia either very short and subulate, or half an inch long and once or twice forked. *Conceptacles* clustered around the base of the shorter cilia. *Colour* rose-red or brownish. It scarcely adheres to paper." ●

This plant I have not seen. Prof. J. Agardh seems to doubt whether it may not more properly be referred to *Calliblepharis*. His quotation of "*Rhod. ciliata* β. *microphylla*, Bot. Beech. Voy. p. 164," is incorrect.

IV. PLOCAMIUM. *Lamour.* (reform.)

Frond sub-cartilagineo-membranaceous, linear, plano-compressed, pinnately decompound (the pinnules alternately secund in pairs, or in threes and fours): composed of two strata of cellules; the inner cellules longitudinal, oblong, the outer polygonal, coloured, small. *Conceptacles* sessile or pedicellate, hemispherical, with a cellular pericarp finally opening by a pore; *sporiferous filaments* very numerous, radiating in several tufts (some generally barren) from a basal placenta; the fertile forming masses of spores from their upper cells. *Tetraspores* lodged in proper spore-leaves (*stichidia*), oblong, zonate.

A beautiful genus, readily distinguished by the very peculiar ramification. The frond in all is linear, distichously branched, two-edged or flat, sometimes membranaceous and furnished with a midrib, sometimes thickened and cartilaginous, pin-

nately decompound. The pinnules are of two kinds; the *primary* or lowest in position are generally simple, short, acute, either subulate or cultrate, and are set distichously at alternate sides of the branch; the *secondary* are pinnulate or pectinato-decompound, and spring singly, or two, three, or four consecutively from above the axil of their primary, in the space between its place and that of the next primary at the opposite side of the stem. In this way, the ramuli throughout the frond are alternately geminate, ternate, quaternate, etc. In one section of the genus, peculiar to the southern hemisphere, the ramuli are geminate; that is, each primary subtends but one secondary ramulus; in the other section, to which our *P. coccineum* belongs, two or more secondaries are ranged above each primary. All the species are remarkable for their brilliant colour.

1. *PLOCAMIMUM coccineum*, Lyngb.; frond narrow, cartilaginous, plano-compressed, decompound; ramuli alternately ternate or quaternate, the lowest of each series subulate, very entire, the upper pectinate on their upper edges; conceptacles marginal, solitary, sessile; spore-leaves on the inner faces of the pectinate ramuli, divaricately branched. *Harv. Phyc. Brit. t. 44. J. Ag. Sp. Alg. 2, p. 395. Kütz. Sp. Alg. p. 883. Fucus coccineus, Huds. Turn. Hist. t. 59. E. Bot. t. 1242.*

HAB. San Francisco, California, *Dr. Sinclair, Capt. Pike*. Boston Bay, *Miss Hawkshurst*. (v. v.)

Captain Pike's specimen is about four inches high, a line broad, alternately and distantly branched, the stem and branches two-edged, but not much compressed below, flatter above. *Branches* decompound in their upper half. *Ramuli* generally alternately ternate or quaternate, the lowest ramulus subulate, about a line long, the two above it elongate, compound in a similar order. *Stichidia* formed from the ultimate ramuli of the upper divisions of the branches, palmate or dichotomous, the divisions truncate. *Colour* a dark lake-red. *Substance* cartilaginous. It imperfectly adheres to paper.

The rarity of *Plocamium coccineum* on the eastern shores of North America is very remarkable, considering that it is common on the Atlantic shores of Europe, and throughout a very wide extent of the Southern Ocean. The Californian specimen above described is more robust, more cartilaginous, and less compressed than any that I possess from other quarters, but offers no peculiarity of ramification by which it can be distinguished.

V. RHABDONIA. *Harv.*

Frond terete, decompound, somewhat tubular; tube partially filled with longitudinal, branching and anastomosing filaments; the peripheric stratum composed of

polygonal cellules, smaller toward the surface. *Conceptacles* immersed in the branches beneath the peripheric stratum, but prominent to one side, the walls formed of a dense plexus of filaments derived from the axis; *placenta* fibro-cellular, central, suspended in the cavity by slender filaments connected with the walls; *spore-threads* emitted in tufts from all sides of the central placenta, moniliform, forming strings of *spores* in their articulations. *Tetraspores* dispersed through the superficial stratum of the frond, oblong, zonate.

I have already remarked under *Solieria* the very close resemblance, in external habit and in the structure of the frond, between the species of that genus and of the present one. Indeed, except in the development of the spores,—a character, however, which obliges us to refer them to widely distant Orders—the two genera are undistinguishable. *Rhabdonia* was founded on two Australian Algæ, very similar in aspect to the plant now to be described; and Prof. Agardh has added four others, one of which is a native of the West Indies, and may possibly occur at Key West.

1. RHABDONIA *Coulteri*, Harv.; frond filiform, setaceous and bare of branches below, gradually incrassated upwards, pinnate or sub-bi-pinnate above; pinnæ and pinnulæ patent, lineari-fusiform, attenuate at the base, obtuse or sub-acute; conceptacles plentiful, half immersed, hemispherical; tetraspores of large size, dispersed. (TAB. XXIII. B.) *Hypnea Coulteri*, Harv. in *Bot. Expl. Exp. ined.*

HAB. Monterey, California, Dr. Coulter. North West Coast, Capt. Wilkes. (v. 8. in Herb. T.C.D.)

Root a large disc, throwing off creeping fibres. *Fronde*s densely tufted, 6—8 inches high, not thicker than hog's bristle below, gradually thickened upwards to the diameter of a crow's quill. *Stem* once or sometimes twice forked within an inch or two of the base, afterwards simple, naked for half its length, closely pinnate or occasionally bipinnate in its upper half, the pinnæ a line or two apart, very patent, 2—3 inches long, the barren ones as thick as sparrow's quill, the fertile ones twice or thrice that thickness. The pinnules when present are in all respects similar, but are very irregularly placed, often secund. *Conceptacles* large, plentifully lodged in the lesser branches, prominent to one side, as if hemispherical or sub-conical. *Tetraspores* dispersed in the branches. *Colour* a very dark, brownish red. *Substance* cartilaginous. It shrinks and scarcely adheres to paper in drying.

Barren plants are setaceous, irregularly divided, and scarcely dilated upwards.

Tab. XXIII. B. *Fig. 1.* RHABDONIA *Coulteri*; the natural size. *Fig. 2,* longitudinal section of a branch, showing *tetraspores* lodged in the surface cells; *fig. 3,* small portion of the periphery of the same, with two tetraspores; *fig. 4,* transverse section of a branch, cutting horizontally through a conceptacle; *fig. 5,* portion of

the same, showing part of the peripheric stratum, of the fibro-cellular wall and placenta, and of the tufts of spore-threads issuing from the latter ; more or less *magnified*.

VI. CORDYLECLADIA. *J. Ag.*

Frond filiform, irregularly branched, carnosu-cartilaginous, formed of two strata of cells ; medullary layer of oblong, longitudinal cells, cortical of roundish, coloured, sub-seriated, vertical minute cellules. *Conceptacles* sessile on the branches, sub-spherical, furnished with a cellular pericarp at length perforate, containing a densely packed globular mass of roundish-angular spores, formed by the evolution of much-branched filaments issuing from a basal placenta. *Tetraspores* immersed in the periphery of pod-like ramuli, oblong, cruciately parted.

The type of this genus is *Gracilaria erecta*, Grev. (*Harv. Phyc. Brit. t. 177.*) ; a little plant, known only on the shores of the British Islands. In the above quoted figure, which in other respects is characteristic, the tetraspores are incorrectly represented as being *zonate*, instead of *cruciate*, as I find them to be on a renewed examination. The two following species are only doubtfully referred to this genus, their fruit being as yet unknown.

1. CORDYLECLADIA ? *Huntii* ; fronds densely tufted, springing from a common, expanded, crust-like disc, livid purple, tereti-compressed, once or twice forked or secundly branched ; branches subulate, attenuate, acute ; fruit . . . ?

HAB. Narragansett Bay, *Mr. Geo. Hunt.* (v. s. in Herb. T.C.D.)

Common crustaceous base, an inch or more in diameter. *Fronds* densely tufted, 2—3 inches high, setaceous below, twice as thick as hog's bristle above, evidently compressed, especially in the upper portion, erect, sub-simple, irregularly divided ; sometimes once or twice forked, sometimes with one or two secund lateral branches, sometimes both forked and secundly branched. *Branches* filiform, attenuated, acute. *Fruit* unknown. *Colour* a livid purplish, fading into white. *Substance* cartilaginous, rather soft, adhering to paper in drying. Medullary stratum composed of polygonal cells, filled with granules and smaller towards the margin ; cortical of minute, coloured sub-seriated cells.

In the absence of fruit this must remain doubtful. I have as yet seen but a single specimen, which I place in this genus from its strong outward resemblance

to *C. erecta*, from which it differs in being evidently compressed, and in the dull purple colour.

2. *CORDYLECLADIA ? irregularis* ; frond filiform, more or less hollow, setaceous, rigid, densely tufted, irregularly branched, somewhat pinnate ; branches few, opposite or secund, widely spreading, simple, obtuse.

HAB. Key West, *Prof. Tuomey*, (5) *Dr. Blodgett*, (45) *W. H. H.* (55) (v. v.)

Frond in densely matted tufts, rising from fibres ? two to three inches high, as thick as hog's bristle, rigid, mostly hollow in the centre, very irregularly branched. Some specimens are pretty regularly pinnate, or sub-bi-pinnate, the pinnae mostly opposite ; others (and these are more common) are set with numerous, lateral, secund branches, which occasionally bear a second series of secund branchlets ; and some fronds have both kinds of branching in different parts. All the branches are patent, of unequal lengths. *Colour* a dark reddish brown, turning green in fresh water, or in decay. A cross-section shows a single row of oblong, coloured, peripheric cells, within which are several rows of irregularly polygonal partially coloured cells, gradually of larger size towards the centre of the axis, where there is an irregular cavity (or deficiency of cells) of greater or less diameter. *Substance* rigid. No fructification seen ; but some of the tips of the branches are slightly expanded, as if designed to contain tetraspores. In drying it scarcely adheres to paper.

I am very doubtful of the generic relation of this plant, but can think of no more convenient place to put it, the fruit being unknown, than in this genus.

ORDER XI. CRYPTONEMIACEÆ.

Cryptonemææ and *Gigartineæ*, with part of *Dumontieæ*, *J. Ag. Sp. Gen. and Ord. Algarum*, pp. 165, 229, 346. *Cryptonemææ* (excl. gen.) *J. Ag. Alg. Medit.* p. 66. *Endl. 3d. Suppl.* p. 36. *Harv. Man. Ed. 2*, p. 131, &c.

DIAGNOSIS. Purplish or rose-red sea-weeds, with an inarticulate (cartilaginous, horny, coriaceous, or gelatinous, rarely membranaceous) frond, composed wholly or in great part of articulated confervoid filaments, compacted together by gelatine ; the membranous species sometimes composed of polygonal cells gradually smaller toward the surface. *Nucleus* either sunk in the frond or lodged in an external

conceptacle, simple, or formed of several associated nucleoli. *Spores* congregated without order in the fertile cells or nucleoli.

NATURAL CHARACTER. *Root* seldom more than a mere disc, rarely accompanied by creeping fibres, or forming a prostrate mat from which numerous stems arise. *Frond* extremely various in size and in outward form, sometimes scarcely an inch in height, sometimes (in the *Iridææ*) two or more feet in length and breadth. Sometimes it is filiform, and then frequently dichotomous, more rarely pinnately parted; sometimes a stipes, soon compressed above the base, gradually widens upwards into an expanded, simple or dichotomous lamina, which is occasionally obsoletely midribbed below. Some laminæ are in such cases proliferous, new frondlets springing either from the surface or apices of the old. Sometimes the frond forms a cylindrical, or moniliformly-constricted, undivided or branching tube, the hollow either filled with air or with loose watery gelatine through which a few filaments are dispersed; and sometimes it is completely bag-like, much inflated, ovate or sub-globose.

The *substance* of the frond is as various as the form. It is frequently cartilaginous, gelatino-cartilaginous, or fleshy, sometimes quite gelatinous; rarely coriaceous, and still more rarely membranaceous; in this last case the membrane has much the substance of parchment. It is usually opaque, sometimes semi-transparent, never exhibiting proper articulations to the eye; but when dissected and thin slices are examined under the microscope, the whole substance of a large majority of the plants of this Order, or a greater or less portion of the frond in the remaining species, is seen to be composed of innumerable, slender, confervoid *filaments*, lying in a transparent gelatine, and variously combined together. These filaments are sometimes cylindrical with long articulations, sometimes moniliform, like strings of roundish or oblong beads, and both forms often occur in the same frond. Cylindrical filaments are more commonly found in the middle or medullary portion, and are then always longitudinal in direction, running parallel with the longitudinal axis of the stem or branch. Moniliform filaments are very common in the periphery or external stratum, where they lie at right angles with the longitudinal axis, or vertical to the surface of the frond. Sometimes these radiating peripheric filaments issue directly, as lateral branches, from the longitudinal ones of the axis; sometimes a net-work of anastomosing filaments, or a stratum composed of large, roundish cells, imperfectly ordinated in rows, intervenes: and in a few cases, (as in *Callophyllis*) the medullary region is composed of large, roundish cells, each cell encompassed by a net-work of very delicate filaments. Such genera conduct us to others in which the frond becomes less and less perfectly composed of filaments; roundish and polygonal cells being more and more introduced into its construction. Thus, in the tribe *Tylocarpeæ*, the whole central portion of the frond is made up of polygonal or honey-combed cells, the periphery alone exhibiting a filamentous character, and even this often in a very imperfect

degree. These latter genera lead us at once in structure to the RHODYMENIACEÆ, from which they can be known only by the structure of the nucleus.

The *sporiferous nucleus* is very frequently sunk in the frond, beneath the filaments of the periphery; where it either lies suspended among those of the inner stratum, or it is encompassed by a dense plexus of filaments, forming a sort of immersed conceptacle, not unlike the *cocoon* of a chrysalis. In a few cases (as in *Chrysomenia*, *Chylocladia*, *Gigartina*, etc.) it is lodged in an external globose or hemispherical *conceptacle*, with or without a terminal pore; and in *Stenogramma* many compound nuclei lie within a linear, rib-like conceptacle, running through the middle of the leaf.

The Order naturally divides itself into two sub-orders, distinguished from each other by the greater or less complication of the nucleus. These have been recently elevated by Prof. Agardh into the rank of Orders, but as it appears to me rather unnecessarily; the difference in nucleatic structure being one of degree only, and the plants of both sub-orders having a most intimate relationship in structure and habit. In our first sub-order (GIGARTINEÆ) the *nucleus* originates in *several* congregated, fertile cells, filled at first with dense granular matter or *endochrome*. These, as the fruit matures, enlarge, while the matter contained in each divides into numerous spores; and each original cell is thus converted into a *nucleolus* of spores, retained within the expanded cell-wall; which then forms (till it disappears) a membranous *periderm* to the nucleolus. The whole *nucleus*, or aggregation of these *nucleoli*, appears at first divided by pellucid lines, marking the boundaries of the mother-cells; but all traces of these generally disappear before the spores are emitted, and at this advanced stage it is not always easy to recognise the proper structure. In our second sub-order (CRYPTONEMEÆ) the *nucleus* originates in a *single* cell, which undergoes similar changes to those just described as occurring in the numerous mother-cells of the first sub-order.

The *tetraspores* are either dispersed among the cellules of the periphery, or collected into definite, superficial, or immersed sori; and in a few cases are formed in external wart-like bodies of irregular shape, called *nemathecia*. They are sometimes zonate, but more commonly cruciate.

This is one of the largest Orders of Rhodosperms, and is dispersed through all latitudes from the Arctic regions to the Equator. Thirty-five genera are described by Agardh, twenty-three of which we already claim for the North American Flora; and probably when our coasts have been more fully examined, several others may be added.

Among the useful plants of the Order is *Chondrus crispus* or Carrageen, so well known as an ingredient in blanc-manges and jellies; and many others, particularly of the genera *Iridaea* and *Gigartina*, numerous large species of which are common on the Pacific coasts, have similar properties.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

SUB-ORDER 1. GIGARTINEÆ. *Nucleus* compound ; consisting of several congregated *nucleoli*, or roundish masses of spores.

TRIBE 1. TYLOCARPEÆ: *Fron*d rigid, compact ; its inner stratum composed of roundish, polygonal cells ; its outer of closely packed, vertical, minute filaments. *Tetraspores* contained in external, raised sori or warts.

* *Fron*d leaf-like, flat. *Conceptacles* external.

I. STENOGRAMMA. *Fron*d dichotomous, membranaceous, rose-red. *Conceptacles* linear, rib-like, medial on the lobes of the frond.

II. PHYLLOPHORA. *Fron*d stipitate, flabelliform, cleft. *Conceptacles* roundish, scattered.

** *Fron*d linear, compressed or filiform. *Conceptacles* immersed.

III. GYMNOGONGRUS. *Fron*d sub-terete, compressed or flattish, sub-cartilaginous.

IV. AHNFELTIA. *Fron*d terete, horny.

TRIBE 2. KALLYMENIÆ: *Fron*d membranaceous or coriaceous, its inner stratum composed either of longitudinal filaments, or of polygonal cells surrounded by a net-work of filaments ; its outer stratum of roundish or polygonal cells, smaller towards the circumference, the cortical cellules disposed in minute vertical filaments.

* *Fron*d cylindrical, alternately decompound.

V. CYSTOCLONIUM.

** *Fron*d flat, its inner stratum composed of large, roundish cells, surrounded by a net-work of anastomosing filaments.

VI. CALLOPHYLLIS. *Fron*d dichotomous, bright red.

*** *Fron*d flat, its inner stratum composed of longitudinal, interlaced filaments.

VII. KALLYMENIA. *Fron*d sub-sessile, expanded, indefinite in form.

VIII. CONSTANTINEA. *Frond* caulescent, branched ; the branches expanding into carnosocoriaceous definite laminae.

TRIBE 3. EU-GIGARTINEÆ : *Frond* cartilaginous, wholly composed of innumerable, slender, anastomosing, longitudinal and horizontal filaments, set in a firm, pellucid gelatine. *Tetraspores* collected in sori.

* *Nucleus lodged within a pseudo-pericarp, composed of densely interwoven filaments.*

IX. GIGARTINA. *Frond* terete or flat, mostly branched. *Conceptacles* external, globose.

X. IRIDÆA. *Frond* flat, simple or vaguely cleft. *Nuclei* immersed in the frond.

** *Nucleus immersed in the frond, without definite border.*

XI. CHONDRUS. *Frond* dichotomous, flabelliform.

TRIBE 4. ENDOCLADIEÆ: *Frond* cartilaginous, terete, sub-tubular, formed of a solitary, longitudinal, articulated, axial filament, from which short, horizontal, fastigiate filaments issue on all sides, and are united by firm gelatine into a continuous peripheric stratum.

XII. ENDOCLADIA. Peripheric filaments whorled.

XIII. GLOIOPELTIS. Peripheric filaments alternate.

SUB-ORDER 2. CRYPTONEMEÆ. *Nucleus* simple ; consisting of a single roundish mass of spores.

TRIBE 5. GASTROCARPEÆ: *Frond* membranaceous or sub-gelatinous ; its inner stratum (sometimes obsolete in the tubular fronds) composed of elongated filaments variously anastomosing ; its outer stratum of one or more rows of roundish-polygonal cells, smaller towards the surface, and coalescing into a membranous cortical layer.

* *Frond rigidly membranaceous, flat and leaf-like.*

XIV. CRYPTONEMIA.

** *Frond either filiform or flat, very lax within, or sometimes tubular and inflated.*

† *Conceptacles external with a definite pericarp.*

XV. CHYLOCLADIA. *Conceptacles* external, sessile, conico-acuminate, containing a mass of spores surrounded by a gelatinous limbus. *Frond* tubular, linear.

XVI. CHRYSYMENIA. *Conceptacles* half immersed in the frond, obtuse or acute, containing a very dense, depressed-spherical mass of minute spores attached to a basal placenta. *Frond* compressed or inflated, hollow or subsolid.

†† *Sporiferous nuclei immersed in the frond.*

XVII. HALYMENIA. *Frond* flat or compressed, dichotomous or pinnate.

††† *Nuclei unknown (station in the Order doubtful.)*

XVIII. HALOSACCION. *Frond* membranaceous, tubular or inflated; the walls of the tube composed on the inside of roundish polygonal cells; toward the surface of minute, oblong, vertically seriated cellules.

TRIBE 6. NEMASTOMEÆ: *Frond* cartilaginous, coriaceous or gelatinous, wholly composed of filaments; the inner stratum longitudinal, interlaced, the outer vertical to the surface and dichotomo-fastigate.

* *Nuclei lodged in terminal, pod-like branches.*

XIX. FURCELLARIA. *Frond* terete, dichotomous, fastigate.

** *Nuclei lodged in terminal, wart-like excrescences.*

XX. ACROTYLUS. *Frond* terete, simple or forked, cartilaginous.

*** *Nuclei dispersed through the unaltered frond.*

† *Frond compressed or flat, solid, and of very compact substance.*

XXI. PRIONITIS. A stratum of roundish cells interposed between the medullary and peripheric strata, which are composed of filaments.

XXII. GRATELOUPIA. Destitute of intermediate stratum; medullary stratum of densely interwoven filaments; periphery of vertical, moniliform, closely packed filaments.

†† *Frond tubular, membranous or gelatinous.*

XXIII. CATENELLA. *Frond* membranous, moniliform; constricted at regular intervals as if jointed. *Nuclei* in minute, contracted ramuli.

XXIV. GLOIOSIPHONIA. *Frond* gelatinous, filiform.

I. STENOGRAMMA. *Harv.*

Frond rose-red, membranaceous, flat, dichotomous and proliferous from the margin, composed of two strata; the inner of several rows of roundish-polygonal empty cells, the outer of minute coloured cellules. *Conceptacles* (resembling a midrib) linear, traversing the medial portion of the fertile lobes; containing, within a thick pericarp composed of radiating cellules, numerous dense clusters of roundish spores, massed together without order; the clusters affixed to all sides of the pericarp. *Nemathecia* superficial, wart-like, scattered, formed of vertical, moniliform filaments, whose articulations are at maturity changed into strings of cruciate tetraspores.

The rare and singular Alga which at present constitutes this very distinct genus was first found at Cadiz in Old Spain by M. Cabrera, and described by the elder Agardh in 1823, under the name *Delesseria interrupta*; the linear conceptacles which are seen on the lobes of fertile specimens having been regarded by the great Swedish Algologist as an interrupted midrib. About ten years subsequently, a solitary specimen, larger and less delicately membranous than the Spanish plant, was brought from California by Capt. Beechey, and described by me in the Botany of Beechey's Voyage as *Stenogramma Californica*. I did not at that time suspect that it had any connexion with the *Del. interrupta* of Agardh, which I only knew by the short description given in the Sp. Alg. vol. 1, p. 179. Some years passed without more being added to the history of this plant. At length, in 1839, Dr. Montagne published a figure in Webb's *Otia Hispanica* of the *Delesseria interrupta*, continuing the Agardhian name. Afterwards, in 1846, the same author found in Bory's Herbarium a specimen, said to have been gathered on the coast of France, agreeing in character with my *S. Californica*; and then for the first time perceived the relationship which the *Del. interrupta*, Ag. bore to it. He accordingly removed the latter plant to the genus *Stenogramma*, calling it *S. interrupta*. Late in the autumn of the same year, 1846,* Dr. John Cocks discovered *S. interrupta* in Plymouth Sound, on the south coast of England, and afterwards dredged it several times in 5—6 fathoms water, the specimens being attached to small stones. All the specimens hitherto seen either produced the linear *conceptacles*, or were barren. The *tetrasporic* fruit was communicated to me in 1848 by Miss Gifford, who discovered it on the Somersetshire coast; but was first described by Dr. Montagne in 1851 (*An. Nat. Hist. ser. 2, vol. 7, p. 481.*) from specimens collected in the Tagus, near Lisbon, by Dr. Welwitsch. In the summer of 1851, I received from New Zealand numerous specimens with both kinds of fruit; and in the autumn had the pleasure to hail it as a native of Ireland, Mr. Isaac Carroll having dredged specimens with conceptacles and tetraspores in Cork Harbour. I have now had the advantage of examining and comparing together specimens from all the above localities, and the result is a conviction that all belong to one species; though the frond is

* Misprinted 1847 in Phyc. Brit. t. 157.

liable to some small variety in substance and ramification. The New Zealand specimens are much the largest that I have seen ; but the lobes in the original Californian fragment being still broader, it is probable that the specimens hereafter to be brought from the latter country will surpass any now in our collections.

1. *STENOGRAMMA interrupta*, Mont. *Harv. Phyc. Brit. t.* 157. *J. Ag. Sp. Alg.* 2, p. 391. *Kütz. Sp. Alg. p.* 873. *Delesseria interrupta*, *Ag. Sp. Alg.* 2, p. 179. *Mont. in Webb. Ot. Hisp. t.* 8. *Stenogramma Californica*, *Harv. in Bot. Beechey, p.* 408. (TAB. XIX. C.)

HAB. San Francisco, California, *Dr. Sinclair*. A fragment picked up at Key West, Florida, *W. H. H.* (41.) (v. v.)

Root discoid. *Fron*d stipitate, the stipes compressed upwards and passing into the cuneate base of a flabelliform, dichotomously cleft lamina, 4—8 or 10 inches in length, and as much in expansion. *Laciniae* linear, obtuse, repeatedly forked ; sometimes irregularly dichotomous, sometimes palmately or alternately cleft, and often furnished at the edges with proliferous, oblong or forked leaflets. Barren fronds, as well as those destined to produce *nemathecias*, are quite nerveless. In fertile or conceptacle-bearing fronds, a slender pseudo-nerve runs through the centre of each fertile lobe, commencing just below one of the furcations, and terminating nearly opposite to a lower fork. In this pseudo-nerve the conceptacle is formed, a less or greater portion becoming thickened, dark coloured, hollow within, and developing from its medullary cells very numerous *nucleoli*, which are densely aggregated together into a linear, sausage-like nucleus. The *tetraspores* are evolved from the radiating filaments of blotch-like, dark red *nemathecias*, scattered irregularly on both surfaces of the frond, and originating in a transformation of the cells of the cortical layer. The substance of the frond is membranaceous, rather rigid below, flaccid, and often delicately thin above. The colour is a fine clear pinky red. In drying, it scarcely adheres to paper.

Our figure is taken from the original Californian specimen, now preserved in Sir William J. Hooker's Herbarium, and represents the base of the frond and one of the two principal segments into which it divides. This specimen is more rigid in substance and darker in colour than ordinary European specimens, but an extensive suite from New Zealand connect it with the smallest and most delicate varieties. My specimen from Key West is fragmentary and barren, but very like some of the smaller European grown fronds.

Plate XIX. C. *STENOGRAMMA interrupta* ; the natural size. *Fig. 2*, the apex of a fertile lobe ; *3*, section through the same (the *nucleus* not correctly analyzed) ; *fig. 4*, spores ; the latter figures *magnified*.

II. PHYLLOPHORA. *Grev.*

Frond stipitate ; the stipes expanding upwards into a rigid-membranaceous, flat, simple or cloven lamina, proliferous from the disc or margin, nerveless or faintly nerved at base, formed of two strata of cells ; the medullary portion of oblong, polygonal, empty cells ; the cortical of minute, coloured, vertically seriated cellules. *Conceptacles* sessile or pedicellate, globose or rugged, closed, containing within a thick pericarp, a *nucleus* composed of several coalescing *nucleoli* or masses of minute spores. *Nemathecia* external, wart-like, scattered, formed of vertical, moniliform filaments, whose articulations are at maturity changed into strings of cruciate tetraspores.

The plants of this genus are generally found attached to rocks, near low water mark, or at a greater depth on exposed coasts. Their root is an expanded disc, from which numerous fronds rise in tufts. The young frond commences by pushing up a filiform stipe, which becomes compressed upwards and passes gradually into the cuneate base of a simple, bifid or dichotomous, somewhat flabelliform lamina. From the margin or disc of this primary frond others similar to it in form but with less developed stipites spring proliferously, and thus the plant continues to grow by successive epiphyllous branches. In some species a faint evanescent midrib may be traced from the apex of the stipes into the lower part of the frond. All are of a rigid substance, scarcely at all adhering to paper in drying. Some are of a fine blood-red colour, others livid purplish. The *nemathecia* or warts containing *tetraspores* afford beautiful microscopic objects.

1. PHYLLOPHORA *Brodiaei*, J. Ag. ; stipe cylindrical at base, compressed upwards, branched, the branches expanding into oblong or wedge-shaped, simple or forked, flat, membranaceous laminæ, which are frequently proliferous from the summit ; conceptacles globose, sessile on the laminæ ; nemathecia spherical, pedunculate, at the tips of the laminæ. *J. Ag. Sp. Alg.* 2, p. 330. *Harv. Phyc. Brit. t. XX.* *Coccotylus Brodiaei*, Kütz. *Sp. Alg.* p. 791. *Fucus Brodiaei*, Turn. *Hist. t. 72.* *E. Bot. t. 1966.*

HAB. Dredged in 4—10 fathom water. Halifax, W. H. H. Maine, Mr. Hooper. Boston Bay, Mrs. Asa Gray. (v. v.)

Stem filiform, as thick as sparrow's quill, 3—4 inches long, compressed upwards, irregularly branched, each branch ending in a cuneate, simple or forked, flat lamina, very variable in breadth and in the amount of division, and very generally proliferous either from the margin or the disc. A large suite of specimens now before me exhibit many curious forms ; in some, the laminæ are from two to four lines wide, cuneate, obtusely bifid or once or twice forked, with a few apical cuneate

frondlets ; in others, the laminae are repeatedly forked, and these strongly resemble *Rhodymenia Palmetta*. In others, a narrow, cuneate, twice or thrice-forked lamina has its ultimate laciniae suddenly widened into cuneato-reniform lobes from one to two inches wide, and either simple, bifid, trifid, or more commonly truncate and eroded at the summit ; these lobes are so much wider than the laciniae which bear them, that the latter appear like mere stipites in comparison. *Colour* a deep, clear, and full lake red, becoming darker in drying. *Substance* rigid.

I dredged numerous varieties of this plant at Halifax, some of them perfectly resembling the common European form ; others altogether peculiar ; and others approaching so nearly to the Antarctic *Ph. cuneifolia*, Hook. and Harv. (from the Falkland Islands) as to render the specific validity of that plant doubtful.

2. *PHYLLOPHORA membranifolia*, J. Ag. ; stem cylindrical, filiform, branched ; the branches expanding into broadly wedge-shaped, bifid or dichotomous laminae ; conceptacles ovoid, stipitate, rising from the branches or laminae ; nemathecium forming broad, dark-coloured, convex patches in the centre of the laminae. *J. Ag. Sp. Alg.* 2, p. 334. *Harv. Phyc. Brit. t.* 163. *Phyllotylus membranifolius*, Kütz. *Sp. Alg.* p. 790. *Fucus membranifolius*, Turn. *Hist. t.* 74. *E. Bot. t.* 1965.

HAB. Boston Bay (in fruit), *Mrs. Asa Gray*, *W. H. H.* Newport, Rhode Island, *Prof. Bailey* and *Mr. S. T. Olney*. New York, *Messrs. Hooper and Calverley*. Long-branch, New Jersey, *Miss Morris*. (v. v.)

Stem filiform, three to four inches long, as thick as sparrow's quill, irregularly divided ; branches ending in fan-shaped, repeatedly forked, flat laminae, one to two inches long. *Laciniae* cuneiform, widely spreading, with very wide, rounded axils, two to four lines broad, obtuse. *Conceptacles* as large as rape-seed, stipitate, scattered on the branches or laminae. *Colour* a dull brownish-purple or livid. *Substance* rigidly membranaceous.

III. GYMNOGONGRUS. *Mart.*

Frond carnosio-coriaceous, terete, compressed, or flat, linear, dichotomous, composed of two strata of cells ; the medullary stratum of roundish-angular, empty cells ; the cortical of moniliform, vertical, closely packed, short filaments, formed of minute, coloured cellules. *Conceptacular-nucleus* immersed in the frond, more or less prominent, consisting of several associated *nucleoli* or masses of minute spores. *Nemathecium* external, hemispherical, wart-like, formed of radiating, moniliform filaments, whose articulations are at maturity changed into strings of cruciate tetraspores.

Readily distinguished from the last genus by the narrow, generally sub-terete frond, never expanding into membranous leaves, and by the immersed conceptacular fruit. In external habit the *Gymnogongri* much more nearly resemble species of *Chondrus*, in which genus several were formerly included, but they differ from the true *Chondri* essentially in the structure of their medullary stratum. Nearly twenty species are already known, natives of various parts of the world.

1. *GYMNOGONGRUS Torreyi*, J. Ag. ; "frond compressed, flattish, dichotomous, fastigate ; the segments linear, very narrow ; the axils rounded." *J. Ag. Sp. Alg.* 2, p. 319. *Sphærococcus Torreyi*, Ag. *Sp.* 2, p. 254.

HAB. New York, *Prof. Torrey* in Herb. Agardh.

"*Fronde*s a span long, regularly dichotomous, nearly terete below ; segments linear, very narrow, scarcely a line broad, gradually attenuated toward the obtuse apices. *Axils* rounded ; all the segments ascending and forked at the summit. *Substance* coriaceo-corneous, rigid. *Colour*, in the dry state, brownish." Ag.

I have not seen an authentic specimen of this plant, but have received from *Mr. Hooper* a small fragment, which may possibly belong to it. It was found at Fort Hamilton, and is about an inch high, and half a line in diameter, compressed, flabelliform, fastigate, dichotomous, the segments divaricating, obtuse, or sub-truncate, sometimes emarginate. *Colour* a very dark red-brown. *Substance* cartilagineo-coriaceous. *Structure* as in the genus. This specimen resembles *G. Griffithsiae*, but is broader and more compressed, and the medullary cells are rather different. It is well worth the attention of the Brooklyn Algologists to endeavour to clear up the history of this little-known species.

2. *GYMNOGONGRUS tenuis*, J. Ag. ; "fronds tufted, flat, membranaceous, dichotomous, sub-fastigate ; segments linear, the upper ones narrower ; conceptacles scattered, hemispherically prominent towards one surface of the lamina, flat towards the opposite surface." *J. Ag. Sp. Alg.* 2, p. 319.

HAB. On the shores of the Mexican Republic, *Liebman*, (v. s. in Herb. T. C. D.)

Densely tufted, about an inch and half high, dichotomously-decompound, the upper segments narrow or multifid. *Axils* sub-acute. *Colour* purplish. *Substance* membranaceous, thin.

Nearly related to *G. Norvegicus* but thinner in substance, of a purplish colour, and with more prominent conceptacles. I am indebted to Senator Binder of Hamburgh for an authentic specimen.

3. *GYMNOGONGRUS Norvegicus*, J. Ag. ; frond linear, dichotomous, flat, fastigate ;

the axils patent, rounded ; apices obtuse ; conceptacles imbedded in the upper segments, numerous, slightly prominent toward both surfaces ; nemathecium sessile, hemispherical, densely scattered over both surfaces of the frond. *J. Ag. Sp. Alg.* 2, p. 320. *Chondrus Norvegicus*, Lamour.—*Harv. Phyc. Brit.* t. 187. *Oncotylus Norvegicus*, Kütz. *Sp. Alg.* p. 789. *Fucus Norvegicus*, Turn. *Hist.* t. 41. *E. Bot.* t. 1080. *Chondrus dubius*, Mont. *Fl. Alg.* p. 117.

HAB. Penobscot Bay, Maine, Mr. J. Hooper. (v. v.)

The only American specimen of this species which I have yet seen is two inches long, about a line in diameter, and irregularly dichotomous ; about four or five times forked, the segments linear, divaricating, and the axils remarkably rounded. It bears two or three young nemathecium ; and the cellular structure is exactly as in the European plant. Notwithstanding the northern locality from which it comes, Mr. Hooper's specimen much more nearly resembles the narrow Algerian variety called *Chondrus dubius* by Montagne, than any specimen I possess from the English or Irish coasts.

4. *GYMNOGONGRUS linearis*, J. Ag. ; frond stipitate, slightly channelled or flattish, dichotomous, fastigiate ; segments linear, somewhat thickened at the margin, very entire, the terminal ones obtuse, rounded, and dilated ; nemathecium sub-globose, plentiful on the upper lacinia, and almost always protruded on the concave surface of the lobe. *J. Ag. Sp. Alg.* 2, p. 325. *Chondrus linearis*, Grev.—Kütz. *Sp. Alg.* p. 738. *Fucus linearis*, Turn. *Hist.* t. 220.

HAB. At Port Trinidad, Pacific Coast, Lat. 41° 12' N., A. Menzies, Esq. (v. s. in Herb. Menzies).

Frond four to six inches high, stipitate. *Stipes* sub-cylindrical, and as thick as a crow's quill at the base, very soon compressed, then flattened, somewhat channelled, one to two lines in diameter, two to three inches long, forked at the summit, after which the flabelliform frond is repeatedly dichotomous. *Lacinia* linear, slightly channelled, the terminal ones broader and cuncate, very obtuse or subemarginate ; or else bifid, each apex truncate. *Nemathecium* very convex, as large as rapeseed. *Colour* a dark red-brown, more rufous in the tips. *Substance* cartilaginous. It does not adhere to paper in drying.

In aspect this species is not unlike *Chondrus crispus*, but is widely different in structure.

IV. AHNFELTIA. J. Ag.

Frond cartilagineo-corneous, subterete, dichotomous or secundly proliferous, composed of two strata or cells ; the medullary stratum of very slender, densely packed

elongated cells, longest towards the centre, shorter toward the margin ; the cortical of moniliform, vertical, closely packed, short filaments formed of minute coloured cellules. *Conceptacular nucleus* immersed in the frond, sub-prominent, consisting of several associated *nuclei* or masses of minute spores. *Nemathecium* (?) external, surrounding the branches, wart-like, formed of radiating, very densely packed, slender filaments.

Nearly related apparently to the last genus, with which I have formerly felt disposed to unite it. It differs, however, in the much greater density of cellular structure and more rigid substance of the frond. The typical species, *A. plicata*, is widely dispersed, being common on both shores of the Atlantic, in the Pacific Ocean, and extending into high southern latitudes. The other species are local, and comparatively little known.

1. *AHNFELTIA plicata*, Fries ; frond horny, terete, filiform, very irregularly branched, entangled ; branches di-trichotomous, with lateral proliferous often secund ramuli ; axils rounded, apices curving upwards, the terminal shoots elongate. *J. Ag. Sp. Alg.* 2, p. 311. *Gymnogongrus plicatus*, Kütz. *Sp. Alg.* p. 789. *Harv. Phyc. Brit.* t. 288. *Fucus plicatus*, Turn. *Hist. tab.* 180. *E. Bot. tab.* 1089. *β. fastigiata* ; frond more regularly dichotomous, the apices of equal length, *Gymnogongrus fastigiatus* Post. and Rupr. ! *Alg. Russ.* p. 16.

HAB. Boston Bay, Mr. G. B. Emerson, Dr. Asa Gray, &c. Rhode Island, Prof. Bailey. New York, Mr. Calverley. *β.* Unalashka, Wosnessensky ! Halifax, W. H. H. Boston Bay, Mr. Emerson. (v. v.)

Fronds densely tufted, often forming intricate bundles some inches in diameter and 9 or 10 inches long. *Stems* filiform, twice as thick as hog's bristle, very irregularly branched, more or less dichotomous, especially below ; the lesser divisions often lengthened and beset with lateral alternate or secund, erecto-patent branchlets. In var. *β.* the tufts are often perfectly level-topped as if clipped with a shears ; the fronds regularly dichotomous with distant lower forks and approximate upper ones. *Colour* a blackish purple. *Substance* very rigid and wiry. It does not adhere to paper in drying.

I have been favoured by Dr. Ruprecht with an original specimen of his *Gymnogongrus fastigiatus*, but can by no means distinguish it from a fastigate variety of *A. plicata* which accompanies the ordinary form in Boston and Halifax Harbours.

2. *AHNFELTIA gigartinoides*. *J. Ag.* ; "frond carnosio-corneous, terete, dichotomous and secundly decompound-proliferous ; the proliferous ramuli very patent, obtuse ; the segments erect from the rather acute axils, the terminal ones elongate." *J. Ag. Sp. Alg.* 2, p. 311. *Gymnogongrus gigartinoides*, Kütz. *Sp. Alg.* p. 789.

HAB. On the Pacific Coast of the Mexican Republic, *Liebman* ! (v. s. in Herb. T. C. D.)

Closely related to the preceding species, but more robust (half a line in diameter), and softer when moistened, soon decomposing if kept in fresh water.

3. *AHNFEITIA* ? *pinnulata* ; frond rigid, terete, irregularly branched ; branches few, elongate, subsimple, compressed above, and more or less closely pinnulated with setaceous, short ramuli.

HAB. At Key West, rare, *W. H. H.* (42.) (v. v.)

Frond twice as thick as a hog's bristle, 4—5 inches long, terete below, sub-compressed above, very irregularly branched, and chiefly from the lower part. Branches long, arched or straight, sub-simple, either quite naked or set at distances of a line or two apart with setaceous, horizontally patent ramuli. These are two to four lines long, alternate or opposite, sometimes fasciculate or imperfectly whorled, but mostly distichous, as thick as a hog's bristle, distant or crowded. *Colour* a dull, blackish purple. *Substance* rigid and wiry, as in *A. plicata*. The structure of the medullary stratum is very compact and dense, and nearly as in *A. plicata* ; but the cortical stratum is very narrow, composed of very minute cells, in few rows.

I found but two specimens of this plant at Key West. It seems to me to be a well-marked species, and related to the plants of this genus, if not a genuine congener ; a fact which cannot be ascertained without more complete data.

V. CYSTOCLONIUM. *Kütz.*

Frond carnosio-membranaceous, terete, decompoundly branched, composed of three strata of cells ; medullary stratum cord-like, formed of elongated, longitudinal, interwoven confervoid filaments, anastomosing and dichotomous, their branches arching outwards among the large rounded cells of the intermediate stratum ; cells of the cortical stratum small, roundish-angular. *Conceptacles* half immersed in the branches, containing within a thick closed pericarp (formed from the cortical layer) a compound *nucleus*, consisting of several nucleoli or masses of minute spores, separated by sterile filaments. *Tetraspores* dispersed through the cortical layer of the branches, zonate.

This genus, as originally proposed and admirably illustrated by Kützing, in his *Phycologia Generalis* (p. 404, t. 58, fig. I.) is readily distinguished from all neigh-

bouring genera by the structure of the frond detailed above. In external habit the typical species more resembles the *Gracilaria*, among which it was placed by Dr. Greville ; or the *Hypnea* (among which, in the *Phycologia Britannica*, I most unnaturally intruded it) than any of the genera with which the structure of its sporiferous nucleus associates it. In the structure of the frond, as well as in habit, there is a near approach also to *Rhabdonia*, and to *Solieria* ; from both which genera, as well as from *Gracilaria* and *Hypnea*, the structure of the nucleus widely separates it. This latter character, obviously the first in value as indicating natural affinities, brings it into the present Order. *Cystoclonium purpurascens*, our only species, is common throughout the Northern Atlantic, extending on the European side from the glacial ocean to the southern coasts of France.

1. *CYSTOCLONIUM purpurascens*, Kütz. ; frond terete, sub-pinnately decompound, much branched ; branches alternate, elongate, set with alternately decompound ramuli which taper to each end ; conceptacles lodged in the ramuli, one or more forming nodose swellings in each ramulus. *J. Ag. Sp. Alg.* 2, p. 307. *Kütz. Sp. Alg.* p. 756. *Hypnea purpurascens*, Harv. *Phyc. Brit.* t. 116. *Fucus purpurascens*, Turn. *Hist.* t. 9. *E. Bot.* t. 1243. β . *cirrhusa* ; the branches drawn out into long, twisted tendrils.

HAB. On littoral fuci, &c. Common from Halifax to New York Harbour. Squan, New Jersey, *Miss E. Morris*. β . Rye Beach, New Hampshire, *Miss Frothingham*. (v. v.)

Fronds six to twelve inches long or more, as thick as a crow's quill below, attenuated upwards, excessively branched and bushy, alternately decompound ; main branches lateral, elongate, spreading, set with two or more series of smaller branches, the last bearing irregularly scattered subulate ramuli : branches and ramuli acute, tapering to the base. *Conceptacles* imbedded in the ramuli, one, two, or more in each, forming a chain of nodes, the conceptacle being much wider than the place where it is lodged. *Colour* a dark brownish purple or brown, sometimes pale. *Substance* between cartilaginous and membranaceous, shrinking in drying. The frond imperfectly adheres to paper.

β . is a singular form in which the ramuli are converted into spirally twisted tendrils, which coil round neighbouring plants.

VI. CALLOPHYLLIS. Kütz.

Frond carnosomembranaceous, blood-red or rosy, flat, dichotomous or sub-pinnate, formed of two strata of cells ; the medullary stratum of large roundish cells,

smaller toward the surface, each cell surrounded by a net-work of anastomosing cellules; cortical stratum formed of vertical, moniliform filaments. *Conceptacles* immersed in the disc or margin, sub-prominent, roundish, containing within a closed pericarp (formed from the cortical layer) a compound nucleus consisting of several nucleoli or masses of minute spores, separated by a net-work of slender fibres. *Tetraspores* immersed in the frond, scattered, cruciate.

A genus of splendidly-coloured Algæ, chiefly natives of the southern hemisphere. Fronds blood-red, or scarlet-lake, flat, nerveless, dichotomous or somewhat palmate, the laciniaë broader upwards, lobed at the extremity, and frequently fimbriate along the margin. The internal structure of the frond is very peculiar. The medullary portion consists of two or more, sometimes of many, rows of large, empty cells separated by narrow interspaces, through which a delicate net-work of cob-webby filaments permeates. The cortical layer is formed of more or less evolved moniliform, vertical, coloured filaments, set in firm transparent gelatine. Formerly these plants were included in *Rhodymenia*, of which genus they have externally the habit, but from which they abundantly differ in the structure of the frond and of the sporiferous-nucleus.

1. *CALLOPHYLLIS laciniata*, Kütz.; frond sub-cartilaginous, bright red, palmate or flabelliform, cleft into numerous, broad, wedge-shaped segments which are again divided dichotomously; apices obtuse; the margin of fertile specimens curled and fringed with minute ciliary processes, in which the conceptacles are lodged. *J. Ag. Sp. Alg.* 2, p. 299. *Kütz. Sp. Alg.* p. 744. *Rhodymenia laciniata*, Grev.—Harv. *Phyc. Brit.* t. 121. *Fucus laciniatus*, Turn. *Hist.* 69. *E. Bot.* t. 1068.

HAB. Pacific coast, *Mr. Menzies* ! 1788. California, *Beechey*. Atlantic coast, at Cape Henlopen, *Miss Morris*. (v. v.)

Apparently very rare on the American coast. I have as yet only seen a solitary, small, but unmistakable specimen from the Atlantic side of the Continent; and it is difficult to conceive that so conspicuous a plant should be overlooked by collectors were it not extremely rare.

VII. KALLYMENIA. *J. Ag.*

Frond carnosio-membranaceous, flat, irregularly cleft or divided into indefinitely-circumscribed lobes, composed of three strata of cells; the medullary stratum of densely interwoven, branching and anastomosing articulated filaments; the inter-

mediate of large, roundish-polygonal, seriated cells; the cortical of minute, roundish, vertically seriated cellules. *Conceptacles* immersed in the frond, prominent to both surfaces, roundish, containing within a sub-definite pericarp (formed from the cortical layer) a compound nucleus consisting of several nucleoli or masses of minute spores. *Tetraspores* formed from the superficial cellules, scattered, cruciate.

*Fronde*s intensely and generally brilliantly coloured, blood-red or crimson lake, rarely purplish or brownish, of a thickish, membranous, or somewhat cartilaginous substance, soft to the touch, flat, either quite sessile or somewhat stipitate, irregular in form and in division. In the young state the lamina is generally quite simple, roundish, oblong, obovate or reniform; but in age, either from a natural tendency to split, or from the action of the waves, it becomes much divided; sometimes reduced to narrow ribbons; and sometimes, by new proliferous growths from the injured margin, fringed with small lobes or frondlets. Several species have been described, but owing to the great irregularity of form, they are difficult to characterise, and botanists are not agreed as to their exact limits. I have now to add one to the number, which, though founded on very imperfect specimens, I am unwilling to omit from the present Essay.

1. KALLYMENIA *Pennyi*.

HAB. Dredged on a shingly bottom, in 15—20 fathoms water, in Assistance Bay, Arctic coast, *Dr. Sutherland*, (v. s. in Herb. T. C. D.)

Fragments of leaves three to five inches long, and three to four inches broad, but too much injured to enable me to determine the proper outline, are all that I have yet seen of this supposed new species. They resemble *K. reniformis*; but when thin slices of both are placed together on the table of the microscope, the membrane of *K. Pennyi* is seen to be only half the thickness of that of *K. reniformis*, with the medullary net-work more lax, and the cortical cellules larger. The structure seems essentially the same. The colour of the dried specimens is a dark, full-red, somewhat brownish.

At the request of my friend Prof. Dickie of Belfast, I name this interesting plant in honour of the intrepid commander of the Arctic Searching Expedition, *Capt. Penny*, "by whose energy and determination Dr. Sutherland was enabled to reach the locality where it was found." *Dickie in litt.*

VIII. CONSTANTINEA. *Post. and Rupr.*

Fronde caulescent, branched ; branches sub-terete, expanding into carnosio-coriaceous, flat, definite laminæ, composed of three strata of cells ; the medullary stratum of sparingly anastomosing, interwoven, articulated filaments ; the intermediate of rounded cells ; the cortical of very minute, coloured cellules. *Conceptacular nucleus* immersed in the substance of the leaves, consisting of numerous nucleoli, each surrounded with a gelatinous limbus, and containing a mass of minute spores. *Tetraspores* lodged in external warts (*nemathecia*), oblong, zonate.

Nearly related to the preceding genus in artificial character, but differing in the position of the tetraspores, and very dissimilar in external form. Instead of vaguely shaped, stemless fronds, we have here a regularly branching frond, furnished, from its earliest age, with a distinct stem. At first the stem is simple, bearing at its summit a peltate or reniform lamina : by a renewed growth the stem pushes onward through the base of the first leaf (which thus becomes perfoliate or amplexicaul to the new stem) and forms a new leaf at its summit ; and so the frond lengthens, new leaf-bearing internodes continually rising through the bases of the older leaves. After a while they spring in pairs from each leaf-base, and thus the branching becomes normally dichotomous ; but as one internode of the fork is often abortive, old specimens are frequently irregularly decompound.

Three species of this curious genus are known ; two of them confined to high latitudes in the Pacific Ocean ; the third to very deep water in the Mediterranean Sea, having been dredged by Prof. Edwd. Forbes in 50 fathoms.

1. *CONSTANTINEA Sitchensis*, *Post. and Rupr.* ; "stem terete, branched, annulated ; internodes separating the rings four times as long as their diameter ; branches expanded at the summit into an orbicular, peltate, entire lamina." *Post. and Rupr. Illustr. p. 18, t. 40, f. 88. J. Ag. Sp. Alg. 2, p. 295. Neurocaulon Sitchense, Kütz. Sp. Alg. p. 744.*

HAB. Isle of Sitcha, Russian America.

I have seen no specimens of this rare and singular Alga.

IX. GIGARTINA. *Lamour.* (J. Ag. ref.)

Frond carnosio-cartilaginous, flat or cylindrical, simple or variously branched, composed of two strata of cells; the medullary stratum of cylindrical, articulated filaments, anastomosing into a very lax net-work; the cortical of moniliform, vertical, dichotomous filaments set in firm gelatine. *Conceptacles* external, globose, finally perforate, containing within a saccate *placenta* (?) formed of closely interwoven filaments, a compound *nucleus* consisting of many confluent *nucleoli* or masses of roundish-angular spores. *Tetraspores* collected into dense, sub-prominent sori, lodged beneath the superficial cells, roundish, cruciate.

Fronds very variable in external habit, sometimes filiform, and either pinnated or dichotomously multifid: sometimes compressed or channelled on one side, sometimes completely flat. The flat species are often expanded into broad, leaf-like, simple or proliferously ramose fronds. The substance in all is thick, between fleshy and cartilaginous, elastic and generally tough when recent; firm, crisp, and somewhat horny when dry. The structure in all is very similar, the inner stratum of the frond consisting of a very lax network of filaments traversing a pellucid gelatine; the outer of vertical, dichotomous, moniliform filaments issuing from the outer meshes of the internal network. (See Plate XXVII. C. fig. 3.)

This genus, as reconstructed by Prof. J. G. Agardh, is very closely related on the one hand to *Iridæa* and on the other to *Chondrus*. From the former it is only to be known by having its *nuclei* lodged in external conceptacles, instead of being wholly immersed in the frond; from the latter by the same character, and by having the nucleus protected by a closely woven cocoon-like plexus of filaments. Some of the species have the external habit of *Chondrus*, in which genus they were formerly placed, and others as strongly resemble species of *Iridæa*.

SECT. 1. EU-GIGARTINA. *Fronds linear, compressed or subterete, pinnately compound. Conceptacles sessile, marginal on the pinnules.*

1. GIGARTINA *canaliculata*, Harv.; frond linear, concave on one surface, convex on the other, naked below, forked or irregularly branched beyond the middle; branches distichously pinnate or bi-pinnate; pinnæ patent; pinnules short, spine-like, divaricating; conceptacles formed in abbreviated, spiniferous pinnæ. *Harv. in Beechey Voy. p. 490. J. Ag. Sp. Alg. 2, p. 272. Chondroclonium canaliculatum, Kütz. Sp. Alg. p. 741. (TAB. XXVII. C.)*

HAB. Shores of California, *Douglas, Coulter, Capt. Pike* (26, 30.) (v. s. in Herb. T. C. D.)

Root accompanied by creeping, branched fibres which throw up numerous, erect stems. *Fronde* densely tufted, two to four inches high, from half a line to a line in breadth, nearly flat, but the margins incurved towards one side, making a channel in the middle of the disc; the *stem* naked for an inch or more above the base, then forked, the segments either simple or again forking, naked below, closely pinnated or bi-pinnate in the upper half. *Pinnæ* distichous, opposite or irregularly placed, from a quarter to half an inch or more long, very patent, simple or set with divaricating, spine-like pinnules. The pinnules in some specimens are mere thorn-like ramuli, but in others are multifid, either irregularly so, or somewhat dichotomous, all the ultimate divisions being remarkably squarrose. *Apices* acute. *Conceptacles* imbedded in the substance of the pinnæ or pinnules, one or more in each, very frequently armed with minute awl-shaped spines, colour very dark blackish purple. *Substance* cartilaginous. It does not adhere to paper in drying unless previously softened by long steeping in fresh water.

A well marked species, probably not uncommon on the Pacific coast.

Plate XXVII. C. *Fig. 1.* GIGARTINA *canaliculata*; the natural size. *Fig. 2.* portion of a frond with conceptacles; somewhat magnified. *Fig. 3.* longitudinal slice of a branch, showing the internal structure; highly magnified.

2. GIGARTINA *mollis*, Bail. and Harv.; frond cartilaginous, plano-compressed, linear, distichous, pinnately branched; branches alternate or opposite, erect, tapering at the base, naked below, pinnated above; ultimate ramuli narrow, sub-filiform. *B. and H. in Bot. Expl. Exped.*

HAB. Pacific Coast at Puget's Sound, *Capt. Wilkes.* (v. s. in Herb. Expl. Ex.)

Frond three to four inches high, from one to two lines in breadth, distichously branched, once, twice, or thrice pinnated, the pinnæ (and pinnules) all very erect, naked below, closely set with pinnules above, narrowed to the base and apex, sometimes forked and then each division pinnated. *Colour* purple. *Substance* cartilaginous, soon decomposing if moistened after having once been dried, and then closely adhering to paper in drying.

Of this I have only seen the few specimens collected in Capt. Wilkes' Expedition. So far as these enable me to speak, the species appears different from any previously described.

SECT. 2. MASTOCARPUS, Kütz. *Frond* thick, dichotomous or sub-pinnate, the segments flat, widening upwards, cuneate or oblong, sometimes very broad. *Conceptacles* formed in papilliform processes issuing from both surfaces of the expanded frond.

3. GIGARTINA *mamillosa*, J. Ag.; frond flattish, channelled, linear, decompound-dichotomous, fastigiate; upper segments wedge-shaped, bifid; papillæ issuing from the disc and margin, tongue-shaped, each containing a single roundish conceptacle.

J. Ag. Sp. Alg. 2, p. 273. *Harv. Phyc. t.* 199. *Mastocarpus mamillosus*, Kütz. *Sp. Alg.* p. 733.

HAB. Newfoundland, *Agardh*. Penobscot Bay, *Dr. Aaron Young*! Newburyport, Massachusetts, *Capt. Pike*! Unalashka, *Lutke*! California, *Dr. Coulter*! (v. v.)

Frond three to six inches high, either regularly or very irregularly dichotomous. flattish, channelled on one side, convex on the other, the segments more or less broadly wedge-shaped, simple or forked, the primary ones in the old specimens throwing out, in a proliferous manner from their surface, numerous similar wedge-shaped, channelled simple or forked secondary segments. *Margin* of the frond incurved, either quite entire and simple, or fringed with small lobes. The surface of all the segments, primary and secondary, especially on the concave side, is very frequently densely set with lobules, or filiform or mamilliform processes of various lengths, some mere tubercles, others linear-wedge-shaped frondlets from a quarter to half an inch long. In these the roundish or ovate *conceptacles* are lodged. *Colour* a very dark purple. *Substance* rigid, somewhat horny when dry. It does not adhere to paper.

The specimens from Unalashka are broader and shorter than those from California. I have not seen any from Newfoundland.

4. *GIGARTINA microphylla*, Harv. ; frond foliaceous, flat, lanceolate, mostly simple (occasionally bifid or trifid), attenuated to the base into a long, slender, linear-cuneate stipe ; both surfaces very densely echinate with minute spindle-shaped soriferous papillæ, and the margin fringed with similar processes. *Rhodymenia?* *microphylla*, Harv. in *Beech. Voy.* p. 164. *Mastocarpus Harveyanus*, Kütz. *Sp. Alg.* p. 734. (TAB. XXVIII. A.)

HAB. Monterey, California, *Douglas*! *Coulter*! (v. s. in Herb. T. C. D.)

Root expanded, fleshy, composed of many confluent discs. *Fronds* tufted ; the stipes at first cylindrical, as thick as a sparrow's quill, soon flattened, gradually widening upwards for two or three inches ; then either forked or trifid, or simply passing into the base of a linear-lanceolate leaf-like lamina, twelve or fourteen inches long or more, an inch or an inch and half wide, and gradually fining off to an acute point. Both surfaces of the lamina are densely clothed with minute, subulate or spindle-shaped processes ; and the margin is also closely fringed with similar ones, which are sometimes lengthened out into marginal lobes from half an inch to an inch in length, and fringed and muricated like the primary leaf. In fertile specimens the papillæ are incrassated. *Sori* one or more in each papilla, immersed, globose, consisting of moniliform strings of cruciate tetraspores. I have not seen conceptacles. *Substance* cartilaginous, thinner than in *G. Radula*. *Colour* a deep, brownish red.

Plate XXVIII. A. *Fig. 1.* *GIGARTINA microphylla* ; the *natural* size. *Fig. 2,* small portion of the lamina, with four fertile, soriferous papillæ ; *magnified.* *Fig. 3,* section of a papilla, through a *sorus*, and 4, a *tetraspore* ; both highly *magnified.*

5. *GIGARTINA spinosa*, Kütz. ; frond somewhat channelled below, thick, cuneate at the base, linear-lanceolate, simple or once or twice forked (the segments sometimes sub-pinnate) ; the margin fringed, and the surface densely muricated with mamilliform or filiform, simple or multifid, acute processes, in which the conceptacles are immersed. *Mastocarpus spinosus*, Kütz. in *Bot. Zeit.* 1847, p. 21. *Iridæa stiriata*, Harv. in *Beech. Voy.* p. 409. (*Excl. Syn.*) *Gigartina ornithorhynchos*, J. Ag. 1849. *Sp. Alg.* 2, p. 274. (TAB. XXVIII. B.)

HAB. California, *Douglas* ; *Coulter*. (v. s. in Herb. T. C. D.)

Root discoid. *Fronds* densely tufted, six to eight inches long, flat or somewhat channelled below, rising with a short cylindrical stem, as thick as a crow's quill, which soon becomes flattened, and gradually widens into the base of the linear-lanceolate lamina. *Lamina* either simple, tapering to both ends, or more frequently once or twice forked, or irregularly 3—4 cleft vertically, the segments in the dichotomous varieties cuneate, those of the others more lanceolate and longer. In some specimens the margin is pinnated with lanceolate or linear wing-like lobes an inch or more in length. Both surfaces are bristled with spine-like, obtuse or acute, simple or compound papillæ in which the conceptacles are borne. *Conceptacles* as large as rape-seed, globose, immersed in the middle or towards the end of the papillæ, the subulate apex of which often extends beyond the conceptacle like the bill of a bird. *Colour* a dark red brown or dull purple. *Substance* coriaceous-cartilaginous, thick and coarse. In drying it shrinks considerably, and does not adhere to paper.

I formerly confounded this species with *G. stiriata*, to which some of the specimens bear a near resemblance, but our plant is less thick and much less gelatinous, and appears to be sufficiently characterised.

Plate XXVIII. B. *Fig. 1.* *GIGARTINA spinosa* ; the *natural* size. *Fig. 2,* a compound papilla, bearing several conceptacles ; *magnified.* *Fig. 3,* segment of a thin section of a conceptacle, shewing a portion of the external wall and of the compound nucleus ; *fig. 4,* spores from the same ; both highly *magnified.*

6. *GIGARTINA exasperata*, Bail. and Harv. ; frond stipitate ; stipes expanding into a coriaceous-membranaceous, broadly lanceolate, entire frond, incrassated at the margin, eroso-dentate and with marginal lobules, both surfaces densely muricated with simple or branched spinous processes in which the conceptacles are lodged. *Bail. and Harv. in Bot. Expl. Exped.*

HAB. Fort Nesqually, Puget's Sound, *Captain Wilkes*. (v. s. in Herb. Expl. Exp.)

Frond two to three feet long, six to ten inches wide, rising with a short stem which soon dilates into a simple, lanceolate lamina, jagged and irregularly dentate at the margin, and rough all over both surfaces, with short simple or forked spines. *Substance* thin, but coriaceous when dry. *Colour* a fine purple. *Conceptacles* formed towards the base of the lamina, in the marginal or discal spines.

Nearly allied to *G. Radula*, but much thinner in substance.

7. GIGARTINA *Radula*, J. Ag. ; frond stipitate ; stipes somewhat channelled, simple or branched ; the branches expanding into thick, fleshy, flat, oblong, ovate, elliptical or obovate entire laminæ, which are either naked or densely muricated with papilliform processes, in which the conceptacles are imbedded. *J. Ag. Sp. Alg.* 2, p. 278. *G. papillata*, Harv. in *Beechey* (not of Ag.) *Mastocarpus corymbiferus*, Kütz. *Sp. Alg.* p. 734. *Fucus bracteatus*, Turn. *Hist.* t. 25.

HAB. North West Coast, *Menzies*. California, *Douglas* ; *Coulter*, *Capt. Pike*, (v. v.)

Fronde (in the Californian specimens) six or twelve inches long or more, three to four inches wide, cuneate or slightly channelled at the base, obovate, obtuse or subacute, sometimes ovato-lanceolate, thick, carnosio-coriaceous, the upper half more or less densely echinate on both surfaces, with mamilliform, acute or obtuse, simple or multifid processes. *Colour* a dark brownish red. A very variable species, common in the Southern hemisphere and on the Pacific coasts. The Californian specimens which I formerly referred to *G. papillata*, Ag. are pretty constantly obovate and quite simple, obtuse, tapering much to the base ; but some are lanceolate, and one is very irregular in shape. At the Cape of Good Hope, where this species is profusely common, many forms occur together ; some having perfectly simple fronds ; others dividing near the base into many segments, or secondary fronds, each of which is stipitate, ovate, obovate or lanceolate. In others each segment is deeply bifid, and in others the frond is somewhat palmate. Specimens bearing tetraspores are quite smooth, destitute of papillæ.

On a careful comparison of the Californian specimens on which Kützinger's *Mastocarpus corymbiferus* is founded, with numerous specimens of *G. Radula* collected at the Cape, I do not see how they are to be distinguished : and this opinion is formed from an examination of a much fuller suite of specimens than Kützinger, to whom I communicated those which he describes, had before him.

X. IRIDÆA. Bory.

Frond gelatinoso-carnose, flat, subsimple, composed of two strata of cells ; the medullary stratum of cylindrical, articulated filaments, anastomosing into a very lax

net-work ; the cortical of moniliform, vertical, dichotomous filaments, set in a firm gelatine. *Sporiferous nucleus* immersed in the substance of the frond, roundish, enclosed in a saccate placenta (?) formed of closely interwoven filaments, consisting of many confluent *nucleoli* or masses of minute spores. *Tetraspores* collected into dense sori lodged beneath the superficial cells, roundish, cruciate.

Technically this genus can only be distinguished from *Gigartina* by having its *nuclei* immersed in the inner substance of the frond, and not contained in external tubercles or conceptacles. The structure of the frond is similar in both genera, but the *Iridææ* have generally simpler, less regularly cleft, and more widely expanded laminae, of a brighter colour and more glossy surface. Their substance is soft, between fleshy and membranous when fresh, somewhat cartilaginous when dry, soon dissolving into gelatine if again moistened after having been once dried. Many species have been described, but I fear often on insufficient data, and I regret that the materials at my command are insufficient to enable me to say, whether all or how many of the following species ought to be retained.

1. *IRIDÆA minor*, J. Ag. ; "frond ovate oblong, sub-simple, smooth, abruptly attenuated into an evident, flattish stipes." *J. Ag. Sp. Alg.* 2, p. 252.

HAB. California, *Douglas*.

"Fronds gregarious, 2—3 inches high, an inch broad, rising with an elongated flattish stipes nearly an inch long, then abruptly cuneately expanded into an ovate or oblong, entire lamina, which is either smooth or verrucated with sub-prominent conceptacles ; rounded and very obtuse at the apex. Colour livid, brownish. Substance gelatinous, cartilaginous when dry." *J. Ag.*

2. *IRIDÆA laminarioides*, Bory ; frond stipitate, linear-obovate or sub-lanceolate, simple or cloven into numerous narrow obovate or lanceolate laciniae ; nuclei densely scattered, sub-prominent. *J. Ag. Sp. Alg.* 2, p. 253. *Kütz. Sp. Alg.* p. 726.

HAB. Russian America, *Postels and Ruprecht*. California, *Douglas ! Coulter !* (v. s. in Herb. T. C. D.)

Stipes one to two inches long, cylindrical at the base, soon cuneate and compressed, gradually widening to half an inch, and then suddenly expanding into the base of a narrow, obovate or oblong, linear frond, one to two feet long, obtuse, or more or less acute or acuminate at the apex. Sometimes the frond divides a little above the apex of the stipes into numerous frondlets ; but this chiefly takes place in spe-

cimens which have grown again after having been injured. Barren specimens are perfectly smooth ; nucleiferous ones are densely verrucose with the very abundant, closely set, depressed, hemispheroidal *nuclei*. Specimens containing *tetraspores* are smooth, but closely dotted over the surface with minute, deep coloured sori. *Colour* a dull brown red, sometimes purplish, fading into greenish. *Substance* rather thick, coriaceous, not very glossy.

My specimens from Douglas (can they be Agardh's *J. minor* ?) are smaller than some of those from Dr. Coulter, but appear to be specifically the same.

3. *IRIDÆA cordata*, J. Ag. ; "frond cordate-ovate, sub-acuminate, smooth, abruptly passing into a very short channelled stipes." *J. Ag. Sp. Alg.* 2, p. 254. *Fucus cordatus*, *Turn. Hist. t.* 116.

HAB. Banks Island, on the N. W. Coast, *Menzies*.

*Fronde*s said to be about a foot long and six inches wide, oblong-cordate, sub-acute, flattish or undulate at the margin.

4. *IRIDÆA punicea*, Post. and Rupr. ; "lamina membranaceous, orbicular in outline, fixed by the margin or lower surface, plaited, here and there perforated, entire or eroso-dentate, of a deep crimson-lake colour." *Post. and Rupr. Illustr.* p. 18.

HAB. Isle of Sitcha, *Postels and Ruprecht*.

5. *IRIDÆA pinnata*, *Post. and Rupr.* ; "lamina membranaceous, thickened, linear, regularly bi-tripinnate, purple ; pinnae and pinnules linear, divaricate, narrowed at the base, very entire or ciliato-pinnate at the margin." *Post. and Rupr. Illustr.* p. 18.

HAB. Norfolk Bay, N. W. Coast, *Postels and Ruprecht*.

Said to resemble *Calliblepharis jubata* in habit, but to have the structure of *Iridæa*. May it not rather be a species of *Gigartina*, possibly our *G. mollis*?

XI. CHONDRUS. *Stack.*

Fronde carnosu-cartilaginous, flat, dichotomous, fastigiate, composed of two strata of cells ; the medullary stratum of cylindrical, articulated filaments anastomosing

into a dense network ; the cortical of moniliform, vertical filaments, set in firm gelatine. *Sporiferous nuclei* immersed in the substance of the frond, somewhat prominent toward one surface, roundish, consisting of many confluent *nucleoli* or masses of minute spores. *Tetraspores* collected into dense sori lodged beneath the superficial cells, roundish, cruciate.

A small genus better distinguished from *Iridæa* by its external habit and firmly cartilaginous substance than by any structural character. Its type in the well-known *Chondrus crispus* or Carrageen (Irish moss), a common littoral plant on both sides of the Atlantic.

1. *CHONDRUS crispus*, Lyngb. ; frond stipitate, flabelliform, dichotomous, fastigiate, flat, the segments linear-cuneate ; nuclei oval, prominent to one surface of the frond, depressed to the other. *J. Ag. Sp. Alg.* 2, p. 246. *Harv. Phyc. Brit. t.* 63. *Kütz. Sp. Alg.* p. 735. *Fucus crispus*, Linn.—*Turn. Hist. t.* 216, 217. *E. Bot. t.* 2285.

HAB. Rocks between tide marks, common on the Atlantic Coast from the shores of British America to those of Long Island. (v. v.)

Frond three to six inches high or more, stipitate, the stipes 1—2 inches long, narrow cuneate, gradually widening to the first fork. *Lamina* flabelliform, fastigiate, many times regularly dichotomous, with patent, rounded axils ; apices either obtuse or acute. In some specimens the width of the laciniae is only a line or two, and they are nearly of equal breadth throughout ; in others the laciniae are half an inch to an inch or more in breadth, decidedly wedge-shaped, flat or very much curled. The substance is between horny and cartilaginous, rigid when dry. *Colour* varying from a dull livid purple to greenish and yellowish. Sori of *tetraspores* (like little drops of blood) scattered over the segments.

2. *CHONDRUS affinis*, Harv. ; frond stipitate, flabelliform, dichotomous, slightly concave or channelled on one side, convex on the other ; segments linear-wedge form ; nuclei abundant, scattered through the segments, prominent to both surfaces. *Harv. in Beech. Voy. p.* 408. *J. Ag. Sp. Alg.* 2, p. 247. *Kütz. Sp. Alg.* p. 737.

HAB. California, *Douglas ; Coulter.* (v. s. in Herb. T. C. D.)

Densely tufted, two to four inches high. *Fronds* rising with a linear, wedge-form stipes, one to two inches long, and somewhat channelled, then forking, and afterwards repeatedly dichotomous, with patent, linear, or wedge-form, slightly chan-

nelled segments and rounded axils; the upper divisions not always regularly dichotomous, but sometimes winged with lateral, secondary segments. Margin of the frond a little thickened and inflexed. *Nuclei* as large as poppy-seed, thickly scattered over the segments, spheroidal, most prominent to the channelled surface of the frond, slightly convex to the convex surface. The plexus of filaments composing the medullary stratum is very lax; the filaments of the cortical layer are minute, moniliform, and densely set. *Colour* a dark, brownish purple. *Substance* cartilaginous. It scarcely adheres to paper.

This plant closely resembles *C. crispus* in external character, but is of a much softer substance and laxer structure, soon decomposing in fresh water.

XII. ENDOCLADIA. J. Ag.

Frond terete, cartilaginous, much branched, muricated with minute spines; the *axis* consisting of a single, articulated, monosiphonous filament, coated with minute cells, from which issue whorls of horizontal, radiating, dichotomous, fastigate, moniliform filaments, whose apices, united by a firm gelatine, form the exterior coat or *periphery* of the frond. *Conceptacles* hemispherical, sessile on the ramuli, containing, within a closed pericarp, numerous laxly aggregated *nucleoli* of angular spores. *Tetraspores* (according to Kützing) exserted, seriated, aggregated in amorphous nemathecia bursting from the tumid upper branches.

A curious and distinct genus, consisting of two species, one of them a native of the Southern Atlantic, the other of the North Pacific Ocean. The frond has externally the habit of a small *Gigartina*, but a cross section of the stem, as shown in our *Plate XXVII. B. fig 4*, shows a very different structure.

1. ENDOCLADIA *muricata*, J. Ag.; frond densely tufted, irregularly much branched; branches flexuous, variously divided, set in the upper part with numerous, divaricated, awl-shaped ramuli; the whole frond muricated with very minute, conical or bifid spinules. *J. Ag. Sp. Alg.* 2, p. 237. *Gigartina muricata*, Harv. in *Bot. Beechey*, p. 409. *Post. and Rupr. Illust.* p. 16. *Kütz. Sp. Alg.* 2, p. 751. *Acanthocladia muricata* and *A. hamulosa*, Rupr.!! (Tab. XXVII. B.)

HAB. Sitcha, Dr. Mertens! California, Beechey! Coulter! Wosnessensky! Capt. Pike! (v. s. in Herb. T. C. D.)

*Fronde*s densely tufted, an inch or two in height, as thick or twice as thick as hog's bristle, irregularly branched; stems either sub-simple, or once or twice forked, flexuous, having several arching, simple or sub-simple lateral branches, beset, especially toward the ends, with short, crowded, similar branchlets. Both primary and

secondary branches taper to a fine point, and are muriculated on all sides with very minute, broadly subulate or conical, simple or slightly bifid spines. The frond is formed of a simple, jointed axial filament of large diameter, with internodes containing endochrome and about thrice as long as broad, coated externally by a thin stratum of minute cellules, from which radiate to all sides numerous, dichotomous, moniliform, horizontal filaments, whose apices, strongly soldered together, unite to form the periphery. The *substance* is firmly cartilaginous, rigid when dry. *Colour* a very dark-red brown. *Conceptacles* spherical, sessile on the ramuli.

Dr. Ruprecht's *Acanthocladia hamulosa* is in all respects identical with my *Gigartina muricata*, first described in the Botany of Beechey's Voyage. His *A. muricata* is more slender and less regularly muricated than most of my specimens, but I do not consider it specifically different. I have not seen any specimens of Agardh's *E. vernicata*.

Plate XXVII. B. *Fig. 1.* Tuft of ENDOCLADIA *muricata*, the *natural* size. *Fig. 2.* part of a frond with conceptacles; *fig. 3.* apex of one of the muricated branches; *fig. 4.* transverse section of the stem; *fig. 5.* longitudinal section of the same; *fig. 6.* vertical section of a conceptacle; the latter figures more or less highly *magnified*.

XIII. GLOIOPELTIS. *J. Ag.*

"*Frond* cylindrical, tubular, lubricous, cartilaginous, dichotomous and branched, composed of two strata; a monosiphonous, articulated, flexuous, axial filament runs through the empty tube, and throws off at alternate sides, di-tri-chotomous, corymboso-fastigate, moniliform, horizontal filaments, which (united by a loose gelatine), form the peripheric stratum. *Conceptacles* hemispherical, containing within a pericarp finally opening by a pore, numerous laxly aggregated *nucleoli* separated by barren filaments running from an axial placenta to the pericarp. *Tetraspores* oblong, cruciate, scattered among the moniliform, peripheric filaments." *J. Ag.*

Two species, with neither of which am I acquainted, constitute the present genus; one of them (the *Fucus tenax*, *Turn. Hist. t. 125*) a native of the Chinese seas, and used extensively in the arts of China and Japan; the other a minute plant from the Northern Pacific, which I give below as being probably a native of Russian America.

1. GLOIOPELTIS *furcata*, *J. Ag.*; "dwarf, tufted; fronds rising from a minute crust, erect, filiform, attenuated at both ends, simple or sparingly forked." *J. Ag. Sp. Alg. 2, p. 235.* *Dumontia furcata*, *Post. and Rupr. Illustr. p. 19.* *Kütz. Sp. Alg. p. 719.*

HAB. In the Northern Pacific, *Mertens*.

"Crust minute, tuberculose, adhering to stones. From this crust spring the fronds, which are half an inch high, rarely an inch, more or less crowded, terete, attenuate at each end, simple or twice or thrice forked, with patent branches. Colour purplish. Substance cartilaginous."

XIV. CRYPTONEMIA. *J. Ag.*

Frond flat, rigidly membranous, sub-caulescent, proliferous or branched, composed of three strata of cells; the medullary of elongated, branched, densely interwoven filaments; the intermediate of roundish cells, towards the surface passing into the minute cells of the cortical layer. *Nuclei* (favellæ) immersed, prominent to one surface, simple, consisting of numerous roundish spores, contained within a hyaline membrane, at length discharged through a superficial pore. *Tetraspores* collected into roundish, wart-like sori, lodged either in special leaflets or beneath the apices of the leaves, oblong, cruciate.

Plants with the rigid substance and the external habit of *Phyllophora*, from which they are well distinguished both by the different structure of the frond and the simplicity of the nucleus. This latter character, combined with the different disposition of the tetraspores and the rigid substance, distinguishes them from *Kallymenia* to which the internal structure of the frond allies them. Six species are described, four of which are peculiar to the southern shores of Europe, and two to the warmer regions of America. One of these last is described below.

1. *CRYPTONEMIA crenulata*, *J. Ag.*; stipes short, soon expanding into a broadly cuneate, bifid or repeatedly forked frond, eroso-denticulate (or rarely sub-entire) at the margin, and proliferous with similarly forked, broadly proliferous frondlets. *J. Ag. Sp. Alg.* 2, p. 225. *Phyllophora crenulata*, *J. Ag. Kütz. Sp. Alg.* p. 791.

HAB. Common at Key West, Florida, *W. H. H.* (v. v.)

Fronds densely tufted, about six inches long, with a short cylindrical stipes as thick as a crow's quill and half an inch long, which rapidly expands into the cuneate base of a membranous, simple or forked lamina. This lamina is one to two inches wide below the first fork; its segments half an inch wide, linear or wedge-shaped, with acute axils, obtuse or truncate apices, and generally an eroso-denticu-

late and minutely curled margin. Sometimes the margin is quite entire and flat. The primary lamina is frequently proliferous from the summit or disc of its lobes with similar secondary fronds ; and these in large specimens bear tertiary ones, the whole resulting in a broadly fan-shaped general outline. *Colour* a clear, deep lake-red, changing to greenish-white in fresh water. *Substance* rigidly membranaceous. It does not adhere to paper. The medullary stratum is formed of densely interwoven filaments ; outside which are several rows of coloured, polygonal cells, the innermost being large, the rest successively smaller ; the superficial ones very minute.

XV. CHYLOCLADIA. *Grev.—J. Ag. ref.*

Frond terete or sub-compressed, (rarely nodoso-articulate,) alternately or pinnately-decompound, tubular ; the tube empty, or traversed by a few slender, longitudinal filaments ; the periphery formed of several rows of roundish-angular cells, successively smaller to the surface. *Conceptacles* external, conical or apiculate, at length pierced by a pore, containing a *nucleus* enclosed in a hyaline mucous envelope, surrounded by a net-work of anastomosing filaments ; the *spores* "originating in the cells of filaments radiating from a placenta, at length" numerous, massed together. *Tetraspores* triangularly parted, dispersed among the superficial cells of the branches.

I adopt this genus as now, by Prof. J. Agardh, restricted to the *Fucus clavellosus*, Turn. Hist. t. 30, and its allies. Among these latter, however, I place the *F. articulatus*, Lightf. notwithstanding its difference of habit, because, as correctly pointed out by Dr. Greville, (Alg. Brit. p. 114) the structure of its conceptacle, both externally and internally, is similar to that of *F. clavellosus*. I have not verified the mode of development of the spores as given in the generic character on Prof. Agardh's authority ; the specimens which I have at hand exhibiting only the nucleus as it eventually becomes, namely, a cluster of disorderly spores contained within a mucous integument, closely resembling a "favella."

1. CHYLOCLADIA *Baileyana* ; fronds tubular, cylindrical, densely tufted, short, irregularly much branched ; branches (mostly arching) divaricated, secund or scattered, their lesser divisions mostly secund, and furnished with a few secund, spindle-shaped ramuli tapering to the base and apex. *C. divaricata*, Harv. MSS. (not of J. Ag.) (TAB. XX. C. Fig. 1.) β *filiformis* ; very slender, elongate, with longer and less arching branches. (TAB. XX. C. Fig. 2) γ . ? *valida* ; frond robust, firm, sometimes with arching, unilateral ramification ; sometimes sub-alternately pinnate.

HAB. Dredged in four or five fathom water. Vars. α and β , Peconic Bay, abundantly, *Prof. Bailey and W. H. H.* Narragansett Pier, *Mr. Olney*. Providence, *Prof. Bailey*. Weymouth Pier, Quincey, Massachusetts, *Dr. Durkee*. γ , abundant in Charleston Harbour, S. Carolina, *Prof. Gibbes and W. H. H.* (v. v.)

Tufts globose, two to three inches in diameter, dense and often intricate, sub-fastigiate. *Fronds* in vars. α and β as thick as hog's bristle, branched from the base in a very irregular manner, all the divisions standing at considerable angles and much divaricated. In var. α all the branches are strongly arched back, or revolute, destitute of branchlets on the concave side, and this ramification is repeated several times. In β the tendency to secund ramification is nearly as great as in α , but the branches are straighter and more attenuate. In γ , which may possibly be a different species, the frond is as thick as sparrow's quill, of firmer substance, and the ramification partakes sometimes of the character of α , sometimes of β . *Conceptacles* unknown to me. *Tetraspores* immersed in the smaller ramuli. *Colour* a pinky red, becoming darker and somewhat brownish when dried. In drying, it adheres closely to paper.

I formerly distributed this plant under the MS. name *C. divaricata*, a name which must be laid aside if the *Fucus divaricatus*, R. Br. be correctly referred by Prof. Agardh to this genus. Nor am I certain whether the specific name now imposed be more than provisional, as future observation may show our plant to be identical with the *Ch. uncinata* of the Mediterranean, a point which I have not at present the means of determining satisfactorily.

However this may be, our vars. α and β appear to form a well marked species. Perhaps var. γ should be separated; being much more robust, more readily recovering its form after having been dried, and when pinnulated, not unlike some states of *Ch. clavellosa*.

TAB. XX. C. Fig. 1. CHYLOCLADIA *Baileyana*, var. α ; fig. 2, var. β ; both of the natural size. Fig. 3, part of a branch of var. γ , with ramuli, containing tetraspores; magnified. Fig. 4, cross section of a branch of var. γ ; and fig. 5, portion of the same, variously magnified.

2. CHYLOCLADIA *rosea*, Harv.; fronds sub-stipitate, distichously-pinnate or bi-pinnate; pinnæ and pinnules elliptic oblong, obtuse or sub-acute, much constricted at the base, compressed, opposite. *Harv. in Phyc. Brit. t. 301 and t. 358 A.*

HAB. On small Algæ in tide-pools, rare. Newport, Rhode Island, *Mr. George Hunt and Mr. S. T. Olney*. β . Portsmouth, New Hampshire, *Dr. Durkee*. (v. s. in Herb. T. C. D.)

Fronds densely tufted, one or two inches high, one to two lines broad, compressed, twice or thrice pinnate; the pinnæ distichous, opposite or rarely alternate, or by suppression unilateral, oblong-linear, much constricted at the base, obtuse, the lowest longest, the rest gradually smaller; pinnules elliptical, very obtuse. *Colour*,

a beautiful rosy red or purplish lake. *Substance* delicately membranaceous. It closely adheres to paper in drying.

Dr. Durkee's specimen, noticed above, is irregularly branched, the primary stems filiform and straggling; the secondary either pinnated or furnished at one side only with pinnules. I have seen British specimens similar to this in ramification.

XVI. CHRYSYMENIA, J. Ag. ref.

Frond subterete, compressed, or flat, tubular or solid, branched; the tube sometimes nearly empty or with a few percurrent longitudinal filaments, sometimes filled with interlaced filaments; peripheric stratum composed internally of large, roundish-angular, inflated cells, externally of minute, coloured, vertically seriated cellules. *Conceptacles* half immersed in the frond, hemispherical or with a prominent orifice, containing a simple *nucleus* (*favella*) fixed to a basal placenta, surrounded by anastomosing filaments, and consisting of very numerous, densely-packed minute spores enclosed within a membrane. *Tetraspores* cruciate, scattered among the superficial cells of the frond.

This genus, as at present constituted, includes plants of very different habit, and in some respects of different structure. In the genuine species (sections *Halichrysis* and *Chrysymenia*, J. Ag.) the frond is dichotomous or pinnated, evidently tubular, but having the tube sometimes compressed, sometimes inflated, nearly empty, or traversed by a very few slender filaments, which are often obsolete in the full-grown plant. In our section *Cryptarachne*, the frond, which is either flat or cylindrical, is more or less densely filled with anastomosing, branched, often closely interwoven filaments, but the external habit of the species is not very dissimilar to that of the former sections. Finally, in the section *Botryocladia*, J. Ag. a much branched, filiform, solid stem bears inflated ramuli, having the proper structure of the genus. The species of this section depart widely in external habit from the rest; and yet they are perhaps nearer in affinity to the typical species than are those of our section *Cryptarachne*.

SECT. 1. CHRYSYMENIA (*Halichrysis* and *Chrysymenia*, J. Ag.); *frond compressed or inflated, evidently tubular; the tube empty or nearly so.*

1. CHRYSYMENIA *Enteromorpha*; frond saccate, fusiform, somewhat compressed, delicately membranaceous, proliferously-decompound; secondary fronds and their

tertiaries strongly constricted at the base, tapering to the apex, springing without order from all sides, and from the apex, of the primary frond.

HAB. Key West, Florida, rare, *W. H. H.* (v. v.)

The full-grown, compound frond is eight or ten inches long or more, and nearly as much in the expansion of the branches. It originates in a simple, saccate, oblong frond, one to two inches long and about half an inch in diameter, rising from a short, cartilaginous stipes, one to two lines long. This primary sac throws out very irregularly, from its sides and apex, numerous secondary sacs of equal breadth, but generally of greater length, three to four inches long, strongly constricted at the base, or rather minutely stipitate, linear-oblong or somewhat obovate and obtuse. These sacs of secondary order, in their turn give off tertiary sacs, which are generally a quarter inch in diameter, more fusiform than the secondary ones, tapering to the apex, and bearing other smaller, more tapering, irregularly set, sac-like ramuli. In large specimens these latter bear others, and thus the frond continues to become compound by successive proliferous repetitions of sac-like branches. *Substance* delicately membranaceous, somewhat gelatinous within. The walls are composed of an inner row of large, empty cells, defended externally by two or three rows of minute, polygonal, coloured cellules. *Tetraspores* abundantly scattered through the cells of the outer coating. *Colour*, a delicate, rosy-red. In drying, it closely adheres to paper.

This plant so much resembles some varieties of *Halymenia ligulata*, that I had at first mistaken it for one of the forms of that sportive species, nor was it till a transverse section assured me that it belonged to a different genus, that I discovered my error. On more closely examining the specimens, an external character is readily found in the ramification; the present species, though it eventually becomes excessively compound, being constituted of numerous series of perfectly *simple* frondlets growing one on the other, and never, that I have seen, *forking*, as do the ramenta of *Hal. ligulata*. Under the microscope, the different structure of the two plants is very obvious.

2. *CHRYSYMENIA halymenioides*; frond compressed, broadly linear, cuneate at the base, dichotomous, fastigiate; the axils rounded, and the laciniae divaricated, very obtuse; conceptacles hemispherical, prominent, scattered. (TAB. XX. A.)

HAB. Thrown up from deep water. Key West, very rare, *W. H. H.*, *Dr. Blodgett*. (v. v.)

Root scutate. *Fronds* one or more from the same base, three to four inches long, a quarter to half an inch wide in the widest part, rising from a slender, filiform base, rapidly widening upwards to the first fork; thence broadly linear and repeatedly and pretty regularly dichotomous. Sometimes from a wounded part a dense

tuft of dichotomous branches spring, making the habit very bushy. The axils are singularly rounded, the laciniae very widely spreading, and the apices remarkably obtuse. The frond is tubular, but strongly compressed and almost flattened. Its walls are thin; the inner stratum composed of polygonal, inflated, empty cells of large size; the outer of very minute, coloured cellules, set in densely packed, vertical filaments. *Conceptacles* plentifully scattered over all the lower laciniae, between hemispherical and conical, prominent. *Tetraspores* dispersed through the superficial cells of distinct plants. *Colour*, a clear, rosy red, becoming brownish in drying. *Substance* soft and lubricous, full of juice. It adheres closely to paper in drying.

This is nearly related to the Mediterranean *C. dichotoma*, J. Ag.; but appears, judging by the description, to differ in some respects. It has much of the external aspect of some varieties of *Halymenia ligulata*, whence our specific name.

Plate XX. A. *Fig. 1.* CHRYSYMENIA *halymenioides*; the natural size. *Fig. 2,* transverse section of a lacinia, cutting through three *conceptacles*; *fig. 3,* portion of the surface, viewed vertically; *fig. 4,* section of the wall of the frond with immersed tetraspores; *fig. 5,* tetraspores; *fig. 6,* section of a *conceptacle*; *fig. 7,* nucleus from the same; *fig. 8,* spores; the latter figures more or less highly magnified.

SECT. 2. CRYPTARACHNE; *frond flat, compressed or cylindrical, sub-solid; the medullary stratum composed of interlaced, anastomosing, branching filaments.*

3. CHRYSYMENIA (CRYPTARACHNE) *Agardhii*; frond gelatino-membranaceous, flat, dichotomously cleft, laciniae cuneate at the base, tapering to the extremity, undulate, unequally eroso-dentate at the margin; the marginal processes sometimes lengthening into linear lobules; *conceptacles* acuminate, scattered over the laciniae. (Tab. XXX. A.)

HAB. Thrown up from deep water, Key West; rare, W. H. H. (v. v.)

Frond six or eight inches long, as much or more in expansion of the laciniae, having a wide, cuneate base, one to two inches long and an inch and half broad, at once dividing into several laciniae, in a somewhat palmate order. These laciniae are simple or forked, or palmatifid, cuneate at the base, about an inch wide at the widest part, tapering to both ends, undulate, with the margin rarely quite entire, more commonly eroso-denticulate. Marginal teeth horizontally patent, very unequal in size, sometimes mere processes a line or two in length, sometimes half an inch long and a line broad. *Conceptacles* scattered over the laciniae, rather prominent, conical, with the orifice very prominent and slightly oblique. The medullary stratum consists of a dense web of branching and anastomosing filaments; the intermediate of several rows of empty cells, of which the inner are very large, the rest successively smaller; the cortical of very minute, coloured, seriated cells, in two or three vertical rows. *Colour*, a pale rose-red, fading and becoming

brownish in drying. *Substance* very gelatinous. In drying, the frond shrinks and adheres very strongly to paper.

The name is bestowed in honour of my friend Prof. J. G. Agardh, to whose opinion (as expressed in a private letter) I yield in retaining this species and its allies for the present in *Chrysymenia*. They differ, as already stated, from the genuine species in having a far more obvious plexus of filaments occupying the centre of the frond.

Plate XXX. A. *CHRYSYMENIA* ? *Agardhii* ; the *natural* size. *Fig. 2*, a section of the frond, and *fig. 3*, a small portion of the same ; *fig. 4*, section of a conceptacle ; all highly *magnified*.

4. *CHRYSYMENIA* (CRYPTARACHNE) *ramosissima* ; frond compressed below, terete above, distichously much branched ; branches patent, with rounded axils, tapering to the base and apex, successively narrower and repeatedly compound, the lesser ones margined with a few spines ; ramuli either filiform, or, when fertile, fusiform, acute and irregularly spinulose ; conceptacles depressed, or sunk in the fusiform ramuli, sphaeroidal. (Tab. XXX. B.)

HAB. Thrown up from deep water ; rare. Key West, W. H. H. (v. v.)

Frond eight to twelve inches long and six to eight inches in the expansion of the branches. Main stem sub-simple, rising from a cartilaginous stipe as thick as a crowquill, soon widening to half an inch in breadth, compressed, tapering gradually to the summit, more or less cylindrical above. This principal stem is furnished throughout, at short distances, with lateral, very patent, distichous branches, issuing at very obtuse angles, tapering to the base and apex like the main stem ; of various lengths, short and long intermixed without order ; the larger ones repeatedly compound in a similar manner. In some specimens the secondary and tertiary branches are very closely set, scarcely more than a line or two apart ; in others they are much more distant. The fertile and barren specimens are also very unlike ; the latter are much more branched, the branches narrower and more finely divided, and the ramuli very slender and abundant ; the former (like that in our figure) have most of the ramuli swollen, broadly fusiform, acute, and sub-dentate. *Conceptacles* lodged in the swollen ramuli, depressed. *Colour*, when growing, a fine, clear rosy red, becoming brownish in drying. *Substance* membranaceous, filled with loose gelatine, which is expelled under pressure, and apt to stain the paper on which the specimen is displayed.

Plate XXX. B. *CHRYSYMENIA ramosissima*, lower part of a fertile specimen ; the *natural* size. *Fig. 2*, a ramulus containing conceptacles ; *fig. 3*, vertical section through a conceptacle ; *fig. 4*, longitudinal section of a branch ; *fig. 5*, filaments of the medullary stratum ; *fig. 6*, transverse section of a branch ; the latter figures variously *magnified*.

5. *CHRYSYMENIA* ? (*CRYPTARACHNE* ?) *acanthoclada* ; stem somewhat distended, (laxly cellular with a dense fibro-cellular axis) divaricately much branched, irregularly decompound ; branches distichous, slender, much attenuated, widely spreading, zig-zag, alternately decompound, aculeate with short, sub-distichous, spine-like, subulate, acute, divaricated ramuli. (TAB. XXV.)

HAB. Thrown up from deep water. Key West, very rare, *W. H. H.* (v. v.)

Root a spreading disc. *Fron*d solitary (?) rising with a stipes half an inch, then branching, either forked, trifurcate or laterally decompound, the main branches incrassated, two to three lines in diameter, simple or forked, set with numerous lateral branches, which are much more slender, alternately-decompound, and very much attenuated at the points, sometimes drawn out almost into setaceous cirrhi. All parts of the frond are distichous and divaricate ; the secondary branches strikingly zig-zag or bent alternately from side to side. *Ramuli* thorn-like, one to two lines long, acute, patent. *Colour*, a deep lake-red when fresh, brownish when dry. *Substance* between cartilaginous and gelatinous. It shrinks much and closely adheres to paper in drying. *Fruit* unknown.

The fruit of this remarkable plant being unknown, its genus is still doubtful, but it seems to me to have many points in common with our *Ch. ramosissima*, and I do not think it placed far from its affinities in the present genus. The perfectly distichous branching and gelatinous substance are worthy of attention in determining its relationship.

Plate XXV. *CHRYSYMENIA* ? *acanthoclada* ; the natural size. Fig. 2, transverse section of a branch ; magnified.

SECT. 3. *BOTRYOCLADIA*, J. Ag. ; stem filiform, solid, branching, beset with inflated, pear-shaped ramuli.

6. *CHRYSYMENIA uvaria*, J. Ag. ; frond cylindrical, solid, dichotomous or irregularly much branched ; branches filiform, beset with scattered or imbricated, inflated, obovate ramuli ; conceptacles depressed, hemispheroidal. *J. Ag. Sp. Alg.* 2, p. 214. *Gastroclonium uvaria*, Kütz. *Sp. Alg.* p. 865. (TAB. XX. B.)

HAB. Thrown up from deep water. Key West, common, *W. H. H.* (26), (v. v.)

*Fron*ds tufted, six to twelve inches long or more, the larger specimens as thick as crow-quills, the smaller as thick as sparrow-quills, cylindrical, solid, firmly cartilaginous, rigid, irregularly much branched, the lower branches sub-dichotomous. Sometimes the upper branches are bushy with a profusion of rod-like or tendril-like lesser branches. The stems and larger branches of old specimens are generally bare, or furnished with a few imperfectly developed ramuli, but all the younger branches, and the whole frond in young specimens, are thickly covered with quadrifarious, obovate, inflated, glossy ramuli. On these ramuli the depressed *conceptacles*

are borne. The *colour* of the stem and branches is dark red ; of the ramuli a brilliant lake. *Substance* of the ramuli succulent and tender.

This very beautiful plant is a native also of the Mediterranean Sea and of the shores of Brazil. It strikingly resembles *Lomentaria ovalis* in ramification, but has a different structure and fructification.

Plate XX. B. Fig. 1. *CHRYSYMENIA uvaria* ; the *natural* size. Fig. 2, a ramulus with *conceptacles* ; fig. 3, section of a conceptacle ; both *magnified*.

XVII. HALYMENIA. Ag.

Frond cylindrical, compressed or flat, gelatinoso-membranaceous or fleshy, dichotomous or pinnated, consisting of a thin, double membrane, separated by a few internal, laxly set, articulated, branching filaments ; membrane composed internally of roundish-angular, empty cells, externally of minute, coloured cellules. *Nuclei* (favellæ) immersed in the frond, suspended beneath the membranous wall, simple, containing numerous minute, densely packed spores, enclosed within a hyaline envelope. *Tetraspores* roundish, cruciate, immersed in the surface cellules, dispersed.

Rose-red Algæ of a very delicate, membranaceo-gelatinous substance, cylindrical or flattened, formed of a membranous coating, enclosing a thin watery gelatine, through which a few articulated, branching and anastomosing filaments are dispersed. The branching is most frequently dichotomous, rarely pinnated ; often proliferous, new frondlets springing irregularly from the sides of the old, especially from wounded places. In fertile specimens the *favellæ* are generally equally dispersed in great numbers through every part of the plant. Several species from various parts of the world have been described, of which I can as yet claim but two as North American : viz.

1. *HALYMENIA ligulata*, Ag. ; frond gelatinoso-membranaceous, compressed or flattish, linear and dichotomous or cuneately expanded and sub-palmate, often proliferous from the disc and margin. *J. Ag. Sp. Alg.* 2, p. 201. *Harv. Phyc. Brit.* t. 112. *Halarachnion ligulatum*, Kütz. *Sp. Alg.* p. 721. *Ulva ligulata*, E. Bot. t. 420. *U. rubra*, E. Bot. t. 1627.

HAB. Thrown up from deep water. Key West, a single specimen only. W. H. H. (v. v.)

The only American specimen of this variable plant that I have yet seen is four

inches long, about five inches in the spread of the laciniaë, flabelliform, sub-fastigate, repeatedly and pretty regularly dichotomous, the larger divisions a third of an inch wide, the upper gradually narrower, and the ultimate ones a line or less in width; apices acute. *Substance*, membranaceo-gelatinous. *Colour*, a fine, clear, pinky red. It closely adheres to paper in drying.

2. HALYMENIA *Floresia*, Ag. ; frond gelatino-membranaceous, flat, stipitate, elongate, pinnately-decompound; pinnae and pinnules linear, acuminate, acute, patent, entire or serrato-ciliate. *J. Ag. Sp. Alg.* 2, p. 205. *Kütz. Sp. Alg.* p. 716. *Fucus Floresius*, Turn. *Hist. t.* 256.

HAB. Thrown up from deep water. Key West, rare, *W.H.H.* (66), *Dr. Blodgett.* (v. v.)

Root a small disc. *Fronds* solitary or slightly tufted, six to eight inches long, and as much in the expansion of the laciniaë, somewhat ovate in outline, flat, and very thin, decompound-pinnatifid. Sometimes the main frond (or rachis) is two or three inches wide, with the margin cut into very densely crowded, bi-pinnatifid lobes, half an inch wide and two or three inches long; sometimes the frond is much more deeply laciniated, the rachis and principal laciniaë not more than half an inch wide; the laciniaë once, twice, or thrice compounded; the secondary ones one or two lines wide, and margined with subulate, tooth-like processes. *Axils* rounded; *apices* all acute and attenuated. *Colour*, a beautiful rosy-red. *Substance* delicately gelatino-membranaceous. In drying it adheres most closely to paper.

An extremely handsome plant. The Key West specimens, here described, closely agree with the Mediterranean ones in *Herb. T. C. D.* Some are very broad, others narrow.

XVIII. HALOSACCION. *Kütz.*

Frond cylindrical or obovate, simple or proliferously branched, hollow, the walls formed of two strata of cells; the inner stratum of two or more rows of roundish-angular cells, the outer of oblong, vertically-seriated, coloured cellules. *Conceptacles* (unknown). *Tetraspores* cruciate, dispersed among the cortical cells.

Until the conceptacular fruit of this genus shall be discovered, its proper position must be considered doubtful. It is almost entirely constituted of Algæ from the higher latitudes of the Atlantic and Pacific, and includes two distinct groups, each characterised by differences of outward form, and by habitat. The Pacific species

are all obovate, and unbranched ; the Atlantic cylindrical, proliferously-ramulose. The substance is rather rigid, and the colour purplish or brownish red.

SECT. 1. HALOSACCION ; *frond simple, obovate.*

1. HALOSACCION *Hydrophora*, J. Ag. ; frond rigidly membranaceous, obovate-oval, turgid, attenuate at the base into a short stipes. *J. Ag. Sp. Alg.* 2, p. 358. *Dumontia Hydrophora*, Kütz. *Sp. Alg.* p. 749. *Fucus saccatus*, Turn. *Hist. t.* 241 ?

HAB. Nootka Sound, *Mr. Menzies*. Puget's Sound, *Captain Wilkes*. (v. s.)

Fronds tufted, three inches long or more, three quarters of an inch wide, very obtuse, oblong or sub-obovate, quite simple, contracted rather suddenly at the base into a very short stipes. *Substance* thickish, like that of parchment, rigid. *Colour* a dull livid purple, passing into green. In drying it does not adhere to paper.

2. HALOSACCION *fucicola*, Post. and Rupr. ; frond simple, membranaceous, obovate-oblong, gradually attenuated at the base into a stipes. *J. Ag. Sp. Alg.* 2, p. 358. *Dumontia fucicola*, Post. and Rupr. Kütz. *Sp. Alg.* p. 720.

HAB. On *Fucus vesiculosus* at Sitcha, *Lütke*. On *Laurenciae* at Monterey, *Dr. Coulter*. (v. s. in Herb. T. C. D.)

Fronds resembling the last species, but thinner and softer in texture, and brighter in colour, purple.

SECT. 2. HALOCOELIA, J. Ag. ; *frond cylindrical, elongate, beset with similar proliferous ramuli.*

3. HALOSACCION *ramentaceum*, J. Ag. ; frond cylindrical, much attenuated at the base, simple or irregularly branched, more or less densely beset with lateral, scattered or crowded, simple or forked, tubular ramenta. *J. Ag. Sp. Alg.* 2, p. 358. *Dumontia sobolifera*, Kütz. *Sp. Alg.* p. 749. *Fucus ramentaceus*, Linn.—Turn. *Hist. t.* 149. (TAB. XXIX. A.)

HAB. Greenland, *Agardh*. Newfoundland, *Despreaux*. Arctic Coast, *Seeman*. Halifax, *W. H. H.* Rye Beach, New Hampshire, *Miss Frothingham*. (v. v.)

Fronds very densely tufted, ten to fourteen inches long, cylindrical, one to two lines wide at the widest part, much attenuated to the base, and more or less tapering to the apex, sometimes quite simple, sometimes dividing an inch or two above the base into several long simple branches. The frond is rarely naked, usually it is

beset, in its upper half, with quasi-proliferous ramenta, given off without order and often very densely fascicled, one to two inches long, filiform, simple or slightly ramulose, sometimes forked, and very often twisted or otherwise distorted, all tapering to the base, and in a less degree to the apex. *Colour*, a dark lurid purple, paler in the ramenta. *Substance* rigidly membranaceous or sub-coriaceous. In drying under pressure, it imperfectly adheres to paper.

A most variable plant in the number and disposition of its ramenta, but easily recognised after it has once been seen.

Plate XXIX. A. *Fig. 1*, HALOSACCION *ramentaceum*; the *natural* size. *Fig. 2*, transverse section of the frond; *magnified*. *Fig. 3*, a small part of the same, more highly *magnified*.

XIX. FURCELLARIA. *Lamour.*

Frond terete, dichotomous, fastigate, solid, composed of three strata of cells; the medullary stratum of densely interwoven, longitudinal, elongate filaments; the intermediate of large, roundish cells; the cortical of small cellules strung together in moniliform, vertical filaments. *Fruit* of both kinds contained in the swollen, pod-like apices of the branches. *Nuclei* (*favellæ*) simple, immersed, formed from some of the cells of the intermediate stratum, numerous in each pod, at length often confluent, each containing many large angular spores in a cluster. *Tetraspores* immersed within the cortical layer, formed in its filaments, large, pear-shaped, transversely zoned.

Very similar in external aspect, and even in the internal structure of the frond, to *Polyides rotundus*, a plant from which it differs so remarkably in fructification, that in a classification founded on differences of fruit, we are compelled to place these genera at opposite ends of our arrangement. The only known species, described below, is common to a wide extent of the Northern Atlantic Ocean.

1. *FURCELLARIA fastigiata*, *Lyngb.*—*J. Ag. Sp. Alg.* 2, p. 196. *Kütz. Sp. Alg.* p. 749. *Harv. Phyc. Brit.* t. 94 and t. 358. *Fucus lumbricalis*, *Turn. Hist.* t. 6. *E. Bot.* t. 846.

HAB. Newfoundland, *Agardh.* (v. v.)

Root, a mat of creeping fibres. *Fronds* 4—8 inches high, nearly a line in diameter, tufted, cylindrical, repeatedly dichotomous, the branches of equal height, the axils and apices acute. When in fruit, the ends of the branches, for an inch or more,

swell into spindle-shaped, pod-like receptacles, which, when mature, drop off, leaving the branches truncated. In these receptacles either *nuclei* or *tetraspores* are lodged; the former sunk among the cells of the intermediate layer, from some of which they are evolved; the latter lying among those of the outer stratum. *Colour* dark red-brown, blackish when dry. *Substance* fleshy, sub-coriaceous when dry.

XX. ACROTYLUS. J. Ag.

Frond terete or compressed, cartilaginous, simple or dichotomous, consisting of two strata; the medullary stratum of slender, elongate, branching and anastomosing longitudinal filaments; the cortical narrow, of minute, roundish, densely packed, coloured cellules, vertically seriated. *Favellæ* (known only in one species) formed in wart-like swellings round the apices, many together, containing within a hyaline periderm numerous angular spores. *Tetraspores* (known only in one species) formed in definitely circumscribed spot-like sori (*nemathecia*) situated below the apices of the segments, elongate, surrounded by slender filaments, zonate.

A small genus founded by Prof. J. Agardh on an East Indian and an Australian species, to the former of which the plant now to be described is closely related. *A. prismaticus*, J. Ag. is described as being prismatically three-or-four-angled, a character which it certainly possesses when dry; but I am of opinion that in the recent state it is cylindrical, like our *A. clavatus*, which, if dried without pressure, also collapses in a prismatic-angular manner, and equally refuses to recover its shape on being moistened after having being dried.

1. *ACROTYLUS clavatus*; frond, from a filiform stipe, club-shaped, terete, obtuse, simple or forked (the branches being then club-shaped,) proliferous from the apex.

HAB. Thrown up from deep water, Key West, W. H. H. (63). (v. v.)

Root a small disc. *Stipes* a quarter to half an inch high, as thick as hog's bristle, filiform, ending in an incrassated collar. *Frond* springing from the centre of the collar, about two inches long, club-shaped, tapering to the base, incrassated and obtuse at the apex, terete, prismatically shrinking when dried without pressure, and not recovering its form on re-moistening, simple or forked. *Colour*, a very dark purplish-red. *Substance* firmly cartilaginous. *Structure* very dense. *Fruit* unknown.

Of this curious plant I collected a very few specimens at Key West, in February,

after strong South Westerly gales. They are apparently immature, but unquestionably congenerous with *A. prismaticus*, with which they agree in structure and substance. Possibly mature specimens may be more compound.

XXI. PRIONITIS. *J. Ag.*

Fronde compressed or flat, linear, dichotomous or pinnate, proliferous or glandular on the disc or margin, composed of three strata; the medullary stratum very broad, of densely interwoven, slender filaments; the intermediate of roundish cells, smaller towards the surface; the cortical of minute, coloured, vertically seriated cellules. *Nuclei* (*favellæ*) immersed either in the frond or its marginal processes, simple, containing roundish spores within a gelatinous pellicle, at length discharged through a superficial pore. *Tetraspores* oblong, cruciate, dispersed among the cells of the cortical layer.

Rather coarse Algæ, of a thick, coriaceous or rigid substance and very dense texture, linear, nerveless, pinnate or dichotomous, often much branched, frequently margined with minute glands, which afterwards grow out into lobules. Most turn very dark in drying.

The species here brought together have been formerly arranged with *Sphaerococcus*, *Gelidium* or *Grateloupia*; and are nearly related to the latter genus, differing chiefly in the more compound structure of the frond. Eight species are enumerated by Agardh, all natives of the Pacific Ocean, three being found to the north, and five to the south of the equator.

1. *PRIONITIS lanceolata*, Harv.; frond plano-compressed, linear, alternately or irregularly branched; branches ligulate, attenuate at the base and apex, naked or pinnate; pinnae lanceolate, distichous, mostly opposite; tetraspores cruciate, immersed in the pinnules. *Prionitis ligulata*, *J. Ag. Sp. Alg. vol. 2, p. 189.* *Gelidium lanceolatum*, Harv. in *Bot. Beechey*, p. 164. (Tab. XXVII. A.) β *angusta*; much more slender, forked, with few and nearly naked branches.

HAB. Prince William's Sound and Nootka, *Mr. Menzies*, 1787. California, *Douglas*! *Dr. Coulter*! β St. Francisco, *Capt. Pike*. (v. s. in Herb. T. C. D.)

Root discoid. *Fronde*s tufted, twelve or fourteen inches long, one to two lines wide, much compressed or nearly flat, linear, tapering to the base and apex, alternately branched or pinnate. The primary branches are several inches long, quite simple, and either naked or distichously pinnulate. *Pinnules* about half an inch

long, lanceolate, not very acute ; sometimes longer and then frequently pinnellated near the end. Along the margin of the *naked* branches or pinnæ, minute gland-like prominences occur at intervals, which I take to be the commencement of pinnules that are often arrested in growth. Here and there a branch occurs, constricted in the middle as well as at the extremities. Many of the branches bear wart-like excrescences. *Tetraspores* are abundantly found in the lesser pinnæ, lying among the cortical cells. *Colour*, a dull brown-red, dark when dry. *Substance* rigid, between coriaceous and horny. It does not adhere to paper.

β , which I have from Capt. Pike, is very much more slender, with very few branches and scarcely any pinnules.

The specimens found by Mr. Menzies are of smaller size and more regularly pinnated than many of Douglas's; but some of Dr. Coulter's are equally well furnished, and thus the two extreme forms are brought together.

Plate XXVII. A. *Fig. 1.* *PRIONITIS lanceolata* ; the *natural* size. *Fig. 2*, transverse section of the frond, showing the cellular structure ; *fig. 3*, small part of the same, showing the peripheric stratum with immersed tetraspores, and the intermediate stratum ; *fig. 4*, tetraspores ; all *magnified*.

2. *PRIONITIS jubata*, J. Ag. ; "frond flat, pinnately decomposed, pinnæ linear, tapering at each end, sparingly denticulate at the margin, pinnated above, the pinnæ lanceolate-linear." *J. Ag. Sp. Alg.* 2, p. 190. *Gelidium crassifolium*, Post. and Rupr. MSS. (*not of Grev.*)

HAB. Floating in the sea, between Asia and Russian America, *Lütke*.

Three or four inches long, or more, sub-stipitate, the primary lamina narrower and thickened. From the upper part of this spring four or five primary pinnæ nearly in palmate order, an inch and half long, much attenuated at the base, two or three lines broad beyond the middle, tapering upwards to the truncate apex. Secondary pinnæ chiefly towards the apices of the primary, much narrower, scarcely a line broad, naked or very sparingly denticulate, pinnate beyond the middle, pinnules here and there aggregated, alternate or secund, sub-acute. *Colour* brownish. *Substance* coriaceous. *J. Ag.*

XXII. GRATELOUPIA. Ag.

Frond compressed or flat, carnosomembranaceous, dichotomous or more frequently pinnate, consisting of two strata of cells ; the medullary of articulated filaments densely interwoven and anastomosing, the cortical of short, moniliform, vertical, closely set filaments. *Nuclei* (*favellæ*) immersed beneath the cortical layer of either

surface, simple, containing, within a gelatinous hyaline pellicle, numerous roundish-angular spores, which are at length discharged through a superficial pore. *Tetraspores* immersed in the cortical layer, scattered, cruciate.

Fronds dark brownish red or purple, sometimes livid, changing to green in decay, strongly compressed or flat, narrow-linear or rarely cuneato-lanceolate, very generally pinnately decomposed, rarely dichotomous; of a compact structure, and soft, membranaceo-gelatinous or carnosio-coriaceous substance, very tough when recent, lubricous, and difficult to detach from the rock on which they grow, membranaceous when dry, shrinking much, and generally closely adhering to paper. The *sporiferous nuclei* are sunk in the frond, but slightly prominent, like little pimples, to either surface, often of small size, and often aggregated in considerable numbers. They communicate with the surface by means of a canal which runs from the nucleus through the cortical layer of the frond, its mouth appearing as a superficial pore. The species are natives of the Tropical Ocean and of the warmer regions of the Temperate zone. One (*G. filicina*) is found as far north as the south of England.

1. *GRATELOUPIA Gibbesii*; frond (one to two feet long) flat, cuneate at the base, polymorphous; lanceolate or wedge-shaped, simple, forked, or alternately multifid; the laciniae very long, lanceolate, acute; margin entire or repand, or fringed with linear lobes which sometimes lengthen into pinnæ; conceptacles immersed in the lamina, minute, scattered. (Tab. XXVI.)

HAB. On the breakwater at Sullivan's Island, Charleston, South Carolina, *Prof. Lewis R. Gibbes* and *W. H. H.*, January, 1850. (v. v.)

Fronds densely tufted, six, twelve, twenty inches in length, the laciniae from half an inch to an inch and half wide at the widest part, tapering very much to the base and apex, flat, coriaceous-membranaceous, and rather thin, with the feel of fine kid leather. The ramification is so different in different specimens, that an adequate conception of the species can hardly be obtained without the comparison of many individuals. In some the frond is quite simple, lanceolate or cuneate, the margin flat, naked, or winged with lanceolate lobes on one or both sides. In others the frond divides at an inch or two above the base into ten or twelve laciniae; each several inches long, tapering greatly to both extremities, either perfectly flat and entire or with the margin undulate and repand, now and then furnished with a few secund pinnæ. Other specimens have the laciniae forked or even palmate near the apex; and in others a primary, linear lamina is pinnated throughout with linear-cuneate, simple or forked lobes. In fact, in the same tuft scarcely two specimens are similarly branched. *Colour*, when growing, a very dark, blackish purple; changing more or less completely to a livid green in drying. *Conceptacles*, which

I have only as yet seen in an immature state, densely scattered through the lobes.

This is the largest and most *fucoid* plant in Charleston Harbour, and one of the noblest species of the genus. In the belief that it is distinct from the *G. Cutleriæ* of Valparaiso, its nearest relation, I give it the name of my friend Prof. Lewis R. Gibbes, as a memento of a delightful day spent in his company on the shores of Sullivan's Island.

Plate XXVI. *Fig. 1.* GRATELOUPIA *Gibbesii*; the *natural* size. *Fig. 2,* a section of the frond, *magnified.*

2. GRATELOUPIA *versicolor*, J. Ag. ; "frond (purple, changing to blackish green,) flat, thickish, pinnately decomposed ; pinnae linear, tapering at both ends, dentatopectinate at the margin, the young teeth acuminate, at length growing out into horizontal, cuneato-linear pinnules." *J. Ag. Sp. Alg. 2, p. 181.*

HAB. At St. Augustin, Pacific coast of Mexico, *Liebman.*

3. GRATELOUPIA *cuneifolia*, J. Ag. ; "frond (blackish green when dry) flat, cuneate or linear, pinnate, here and there dilated and palmate, the margin and disc beset with lesser ciliary processes, segments linear, elongate, rather obtuse." *J. Ag. Sp. Alg. 2, p. 181. Kütz. Sp. Alg. p. 732.*

HAB. La Guayra, Gulf of Mexico, Herb. *Binder.*

4. GRATELOUPIA *prolongata*, J. Ag. ; "frond (violaceous, turning greenish) compressed, nearly flat, undulated, interruptedly pinnate and proliferous from the disc, the apex lengthened out and naked ; pinnae linear-subulate from a narrower base, long and short intermixed together." *J. Ag. Sp. Alg. 2, p. 181. Kütz. Sp. Alg. p. 730.*

HAB. Pochetti, Pacific coast of Mexican Republic, *Liebman*, (v. s. Herb. T. C. D.)

5. GRATELOUPIA *filicina*, Ag. ; frond plano-compressed, pinnately decomposed and proliferous from the disc, pinnae narrowed at base, linear, acuminate, the lowest longest, and often pinnulate, the upper sub-simple ; nuclei numerous, immersed in the disc of the pinnae. *J. Ag. Sp. Alg. 2, p. 180. Kütz. Sp. Alg. p. 730. Harv. Phyc. Brit. t. 100. Fucus filicinus, Turn. Hist. t. 150.*

HAB. Apalachicola, Florida, *Mr. Lounsbury.* (v. s. in Herb. T. C. D.)

I have seen but a single specimen, which appears identical with some of the Mediterranean forms of this variable plant.

XXIII. CATENELLA. *Grev.*

Fronde sub-tubular, constricted at intervals as if jointed, dull purple, membranous; the axile portion composed of a lax net-work of anastomosing, longitudinal filaments, emitting to the periphery dichotomous, moniliform, horizontal branches, whose apices, strongly cohering together, form the membranous wall of the frond. *Nuclei* contained in the axile net-work of minute, ovate or roundish ramuli. *Tetraspores* also in small ramuli, lying among the dichotomous peripheric filaments, zonate.

Small, densely tufted, littoral Algæ of a dark purple colour. *Fronde*s rising from matted creeping filaments, half an inch to an inch or two in height, vaguely branched, constricted into spurious joints, the branches resembling those of an *Opuntia* in miniature. The internodes are somewhat tubular, laterally compressed, hollow, except that a very lax net-work of anastomosing longitudinal filaments runs through them. From the exterior meshes of this net issue to all sides horizontal, dichotomous, moniliform filaments, whose apices, strongly glued together by firm gelatine, form the membranous wall of the frond. *Conceptacles* are very rare. *Tetraspores* are more frequently found.

The genus at present consists of two, or perhaps three species, if the form now to be described be entitled to specific distinction.

1. CATENELLA *pinnata*; densely tufted, rising from creeping filaments; stems erect, once or twice pinnate; branches horizontally patent; internodes oblong, the terminal ones acute, all the ramuli divaricate. (TAB. XXIX. B.)

HAB. On the stems of the mangroves, at high-water mark. Key West, *W. H. H.* (v. v.)

*Fronde*s densely tufted, forming wide patches, rising from prostrate surculi, which are attached to the mangrove trunks by lateral discs. These prostrate surculi throw up numerous erect stems, half an inch to an inch high, divaricately pinnate or bipinnate; the branches horizontally patent, opposite or alternate, either naked or having a few secondary branches which are equally patent, the longer ones bearing a few ramuli. Branches moniliform; the lower internodes sub-cylindrical, the upper compressed, oblong or sub-lanceolate, the ramuli spindle-shaped, acute or sub-acuminate. *Colour* a dark purple. *Substance* membranaceous, rigid. It does not adhere to paper.

Perhaps this is only a variety of *C. Opuntia*; but it is much more regularly pinnated than any form of that species known to me, and the internodes are less frequently obovate.

Plate XXIX. B. *Fig. 1*, *CATENELLA pinnata*; the *natural* size. *Fig. 2*, part of a frond, *magnified*. *Fig. 3*, transverse section, and *fig. 4*, longitudinal semi-section of an internode; highly *magnified*.

XXIV. GLOIOSIPHONIA. *Carm.*

Frond terete, gelatinous, decompoundly much branched; *axis* composed of a column of densely interwoven, longitudinal, articulated filaments, at length hollow and tubular; *periphery* of verticillate, moniliform, dichotomous, fastigate, densely packed filaments, set in gelatine. *Nuclei* (*favellæ*) immersed beneath the peripheric filaments, simple, containing, within a gelatinous envelope, numerous roundish spores. *Tetraspores* unknown.

This genus at present contains but a single species, a native also of the Atlantic Coasts of Europe. It is a brilliant carmine, very much branched, filiform plant, of a very tender gelatinous substance, and wholly composed of articulated, confervoid filaments, invested with transparent gelatine. A cross section of one of the youngest ramuli shows a solitary axial longitudinal filament, from which four verticillate, horizontal, dichotomous, fastigate, moniliform branches issue, whose apices, closely pressed together and united by gelatine, constitute the periphery of the branchlet. An older branchlet, similarly treated, shows a solid columnar axis formed of the union of several filaments, from which spring a proportionably larger number of verticillate peripheric strings of cells. As older branches are successively subjected to the lens, the axis is seen to be more developed, until it results in a vast number of interlaced, anastomosing and branching longitudinal filaments densely packed together. Finally, either from distension, or the perishing of the central cells, the axis becomes hollow in the centre. *Favellæ* are generally very abundantly scattered through the branches. They are wholly immersed, and appear to be attached to the lower branches of the peripheric filaments. *Tetraspores* are unknown.

1. *GLOIOSIPHONIA capillaris*, *Carm.*—*J. Ag. Sp. Alg.* 2, p. 161. *Kütz. Sp. Alg. p.* 714. *Harv. Phyc. Brit. t.* 57. *Fucus capillaris*, *Turn. Hist.* 31. *E. Bot. t.* 2191.

HAB. Nahant, *Mrs. Mudge*. Hampton Beach, *Dr. Durkee*. Chelsea, *Miss E. H. Brewer*. New London, *Miss French*. (v. s. in *Herb. T. C. D.*)

Frond 4—6 inches long, 1—2 lines in diameter, the older parts hollow and tubular, the younger filled with longitudinal threads, excessively and irregularly branched; the branches spreading towards all sides. Main stem sub-simple, terete,

tapering to the base and apex, naked for an inch or two above the base, afterwards very densely set with lateral branches, which are many times decompound, with several series of lesser branches and ramuli. *Ramuli* tapering remarkably to the base and apex; the alternate ones very slender, setaceous, attenuated. *Colour* a brilliant carmine. *Substance* elastic, shrinking in drying. It closely adheres to paper.

The American specimens, here described, closely resemble those from Europe.

ORDER XII. SPYRIDACEÆ.

Spyridiæ, J. Ag. *Sp. Gen. and Ord. Algarum*, vol. 2, p. 337. *Part of Ceramiaceæ*, J. Ag. and Auct. *Harv. Man. Ed. 2*, p. 156.

DIAGNOSIS. Rosy or brown-red sea-weeds, with a filiform, articulate, monosiphonous frond, partially or entirely coated with small cellules. *Conceptacles* external, furnished with a closed, cellular pericarp, containing numerous *nucleoli*, formed by the transformation of spore-threads radiating from a placenta: these spore-threads are much branched, articulated, and produce in their upper cells, by repeated divisions of the endochrome, numerous oblong spores, which are at length massed together without order. *Tetraspores* external, on the ramelli.

NATURAL CHARACTER. *Root* an expanded disc. *Fronde* filiform, articulated, the tube coated externally by a stratum of small, polygonal coloured cellules, which at length conceal the articulations, except in the young branches. *Stem* much branched, alternately or pinnately compounded, all the lesser divisions clothed with minute, setaceous ramelli. *Ramelli* simple, pellucidly articulate, or coated at the nodes with small cellules.

Conceptacles external, pedicellate, roundish or lobed, formed by the metamorphosis of one of the smaller branches. *Pericarp* closed, formed of a stratum of polygonal cells. Its contents are thus described by Prof. J. Agardh: "*Placenta* central, continuous from the peduncle, and prolonged to the apex of the cavity, formed of dense, dichotomo-fastigiate and anastomosing filaments woven together. From this central column of the conceptacle issue filaments (as it were branches) radiating in all directions, many of them elongated and sterile, some shorter and fertile. The sterile filaments are nearly regularly dichotomous, articulated, passing off at the apices into the pericarpal cells; the fertile form many fascicles, directed to the

different lobes ; the younger filaments paniculately branched, with short oblong articulations, the mature ones constituting an obconic cluster of spores. These spores, which originate in a cell-division of the articulations, are oblong ; at length, by mutual pressure, angular, separated from one another and held together by a firm gelatine." *J. Ag. Sp. Alg.* 2, p. 337.

The *tetraspores* are formed along the sides of the ramelli ; either from the evolution of new cells or of those of the cortical layer. They are triangularly parted, and sessile.

At present this Order consists of a single genus, separated by Prof. Agardh from the *Ceramiceæ*, on account of the very different structure of its conceptacular nucleus, a character by which it is more nearly related to the *Rhodymeniaceæ* than to any other family. The structure of the frond, on the contrary, is identical with that of the former family, so much so, that the species of *Spyridia* were formerly referred to *Ceramium* itself.

Possibly when the conceptacles of *Ballia* are better known, that genus will form a second in this very distinctly characterised though at present fragmentary Order.

I. SPYRIDIA. Harv.

Frond filiform, terete or compressed, decompoundly much branched, composed of a single, articulated, thick-walled filament, coated externally with a thin layer of small coloured cellules ; and more or less beset with slender, deciduous, articulated *ramelli*. *Conceptacles* at the ends of short branches or peduncles, involucreted with a few ramelli, containing within a closed, membranous pericarp, numerous *nucleoli* of oblong spores. *Tetraspores* formed along the ramelli, external, sessile, triangularly parted.

The few species of this genus yet known to botanists are all natives of the warmer parts of the ocean. *S. filamentosa* is the most widely dispersed of any, being found throughout the tropics of the Eastern and Western Hemisphere ; in the Mediterranean Sea, and along the Atlantic shores of Europe as far as the South of England ; and on the East coast of North America, from Florida as far North as Massachusetts Bay. As might be expected in a plant of such indifference to climate, it varies much both in the luxuriance of its filaments and the amount of their ramelli ; also, though in a less degree, in the primary ramification. Our var. *refracta* almost looks like a species.

1. *SPYRIDIA filamentosa*, Harv. ; frond filiform, decompoundly branched ; branches alternate, repeatedly divided, ramellose ; ramelli scattered, hair-like, articulate, end-

ing in a simple, acute point. *J. Ag. Sp. Alg.* 2, p. 340. *Harv. Phyc. Brit.* t. 46. *Conferva Griffithsiana*, *E. Bot.* t. 2312. β *refracta*; frond robust, sub-dichotomous, the branches divaricating, with very wide axils, arched; the terminal ones frequently revolute, all but the youngest branches bare of ramelli; ramelli as in the ordinary varieties. (TAB. XXXIV. A.)

HAB. Massachusetts Bay, *Capt. Pike*. Newhaven, *Mr. Hooper*. Stonington and Newport, *Prof. J. W. Bailey*. Red Hook, New York, *Mr. Walters, &c.* Greenport, Long Island, *W. H. H.* Key West, *Dr. Wurdeman*; *W. H. H.* β at Key West, *W. H. H.* (v. v.)

Very variable in size and ramification. *Frond* three to eight or ten inches long, sometimes only as thick as hog's bristle, sometimes twice or thrice as thick; generally much branched, but very irregular in the order of branching. *Branches* spreading, many times compounded, the younger ones especially beset with hair-like ramelli a line or two in length. These ramelli are articulated, each internode formed of a single cell which varies in proportionate length and breadth in different specimens; the nodes are coated with a ring of small cellules, from some of which the tetraspores are evolved in fertile specimens. *Conceptacles* pedicellate, terminating short branches, surrounded by a few involucral ramelli, bi-trilobed, each containing several distinct clusters of spores. *Tetraspores* oval, clustering round the nodes of the ramelli. *Colour* a purplish-red, changing through various shades of brown to dingy yellow-white. *Substance* soft, but not lubricous. It does not adhere strongly to paper in drying, and is without gloss.

β is a very remarkable variety. The frond is of much greater diameter than in the ordinary American forms, and has thinner walls. Our fig. 1 is strictly characteristic of the extreme form of this variety; and I should have considered it specifically distinct, had not intermediate forms accompanied these strangely straggling ones, connecting them with the well-known European vars. *nudiuscula*, *repens*, &c. By Kützinger, indeed, these and other varieties, in all some sixteen, are erected into species; but I fear, were the characters given by this author to be regarded as specific, it would be easy to quadruple the number of *such* species, if a sufficiently extensive suite of specimens were closely examined.

Plate XXXIV. A. *Fig. 1.* SPYRIDIA *filamentosa*, var. *refracta*; the natural size. *Fig. 2.* branchlet and ramelli; *fig. 3.* apex of a ramellus; *fig. 4.* small portion of the stem; *fig. 5.* the same cut open longitudinally; *fig. 6.* a transverse section of the same; more or less highly magnified.

2. SPYRIDIA *aculeata*, Kütz.; frond filiform, decompoundly much branched, branches excessively divided, ramellose; ramelli densely set, hair-like, articulate, having three or more uncinat prickles at the extremity. *J. Ag. Sp. Alg.* 2, p. 342. *Kütz. Sp. Alg.* p. 668. (*Excl. Syn.*) *Spyridia Berkeleyana*, *Mont. Fl. Alg.* p. 141, t. 15, f. 6, *Kütz. l. c.*

HAB. At Sand Key, Florida, *W. H. H.* (74.) (v. v.)

Fronds densely tufted, four to five inches long, as thick as sparrow's quill below, gradually attenuated, setaceous above, branched on every side, bushy, excessively divided. *Branches* virgate, two or three inches long, with a lanceolate outline, closely set with lateral, simple or alternately compounded lesser branches. All the younger parts of the frond are beset with scattered ramelli half a line to a line in length, articulated, the nodes more or less coated with accessory cells and the apex armed with three (or rarely four) hooked prickles, of which one is terminal and the others lateral. *Colour* a fine purplish lake. *Substance* soft, soon decomposing in fresh water. In drying, it adheres to paper.

A much more densely branched and more feathery plant than any variety of *S. filamentosa* which I have seen, and readily distinguished by the hooked spines which terminate the ramelli. On many of my specimens some of the branches are incrassated below the apex; the incrassated portion bare of ramelli and strongly revolute, forming a short tendril. They were not found attached, however, by these hooks to any neighbouring Algæ.

ORDER XIII. CERAMICEÆ.

Ceramicæ, *J. Ag. Sp. Gen. and Ord. Algarum*, vol. 2, p. 1. *Ceramicæ*, *J. Ag. Alg. Med.* p. 69. (in part). *Endl. Gen. Pl. Suppl.* 3, p. 34. *Harv. Man. Ed.* 2, p. 156, &c.

DIAGNOSIS. Rosy or red brown sea-weeds, with a filiform, articulate, or partially or entirely corticated, monosiphonous frond; the outer coat (when present) formed of polygonal cells. *Conceptacles* naked or involucreted *favellæ*; that is, masses of roundish-angular congregated spores, enclosed in a hyaline gelatino-membranaceous saccate envelope. *Tetraspores* external or superficial, formed either from the ultimate ramuli of the simpler fronds, or the cortical cells of the coated ones.

NATURAL CHARACTER. *Fronds* generally growing in dense tufts, sometimes solitary, rising either from creeping fibres or more commonly from discoid roots. In the simpler species, the frond consists of an articulated filament, formed of a number of cylindrical *cells* or *articulations*, placed end to end. This filament is

either dichotomously, or pinnately branched, the branches being similar to the main stem, and always springing from the upper part of each internode (or articulation) either from its shoulder, or from a short distance below that point. In some genera a number of such filaments anastomose together so as to form a net-work or sponge-like frond, each mesh of the net being usually formed by as many cells or articulations as it has sides; none with this habit, however, are yet known as North American. In the filiform species the primary, articulated, filamentous frond has either the simple structure described above, or it is more or less completely covered over and rendered opaque by cortical cellules, which are sometimes developed on the outer surface of the primary cell, but often formed within the thickened cell-walls. The formation of such cortical cells commences at the nodes and proceeds downwards, the lower part of the articulation being the last coated. These cells are frequently deposited in linear series, but sometimes form a honeycombed surface. In several *Callithamnion* the stem, which in the young frond is pellucidly articulate, becomes as the plant advances in age gradually opaque, by the development of numerous longitudinal articulated filaments within the transparent gelatino-cartilaginous cell walls. These filaments originate at the points from which the branches and ramuli spring, and grow downwards toward the base of the stem. They are indeed like roots to the branches; as if each branch sent forth many fibrous roots through the substance of the stem; and in their growth they illustrate, analogically, the similar development of wood tissue from the bases of leaves. In young specimens of *Cal. Baileyi*, the gradual progress of formation of these filaments may be readily seen.

In the more compound fronds, such as occur in the genera *Ptilota* and *Microcladia*, no articulation is visible in the stem, because the primary articulated filament is enclosed in a cellular coat, composed sometimes of many rows of small polygonal coloured cellules. It is only in the very youngest parts of these plants that articulations are partially visible; but, on dissection, the monosiphonous filament which characterises all the plants of this Order is found running, as an axis, through every part of the frond. These opaque species therefore only differ from the pellucidly articulated ones, by the greater development of the cortical cellules.

The *conceptacular* fruit is of the kind called by Agardh a *favella*. It is formed by the metamorphosis of one of the articulations or primary cells of a branch; either of the terminal cell of a shortened branch, or of one of the upper cells. The cell wall dilates, and becomes the transparent envelope or periderm to the *spores*, which are formed by the repeated sub-division of the endochrome of the cell. These *favellæ* are frequently in pairs or clusters, and are either naked or surrounded by short involucreal ramuli.

The *tetraspores* are usually tripartite, rarely cruciate, and still more rarely zonate. They are very frequently external, either sessile on the sides of the ramuli, or on little pedicels, in these cases originating in a transformation of the ultimate divisions of the frond. Sometimes they are half immersed, and rarely wholly sunk among the surface cellules of the compound fronds; in these cases being formed from some of the cortical cellules.

Antheridia have been found in several. They generally occupy the same position on the frond as the tetraspores, and consist of innumerable minute, hyaline cellules strung in moniliform filaments, radiating from a central point; each of these tufts of filaments being about the size of a tetraspore.

Seventeen or eighteen genera of this Order are known. Of these the following are represented on the North American Coasts.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

TRIBE 1. CERAMICEÆ. *Tetraspores* (formed by a metamorphosis of some of the cortical cellules) more or less sunk in the frond.

I. MICROCLADIA. *Frond* not obviously articulate.

II. CENTRO CERAS. *Frond* articulated, corticated; the cortical cells rectangular, longitudinally seriated.

III. CERAMIUM. *Frond* articulated, more or less corticated; the cortical cells roundish, irregularly distributed.

TRIBE 2. CALLITHAMNICEÆ. *Tetraspores* (formed by a metamorphosis of a whole ramulus or of an articulation) external, sessile or pedicellate.

IV. PTILOTA. *Frond* corticated, decompound-pinnate. *Favellæ* involucrate.

V. CROUANIA. *Frond* gelatinous, articulated; the stem and branches moniliform, whorled with minute, densely set ramelli, among which the *favellæ* are sunk.

VI. HALURUS. *Frond* cartilaginous, articulated; branches whorled with forked ramelli. *Favellæ* involucrate.

VII. GRIFFITHSIA. *Frond* gelatino-membranaceous, articulate, dichotomous. *Favellæ* involucrate.

VIII. CALLITHAMNION. *Frond* articulate, (the stem and branches occasionally sub-opaque). *Favellæ* naked.

I. MICROCLADIA. *Grev.*

Frond compressed, decompound-dichotomous, or sub-pinnate, distichous, with an articulated axial filament, corticated, opaque; the cortical stratum formed internally of large angular cells, externally of minute ones. *Favellæ* sessile on the branches, subtended by a few involucral ramuli, and containing, in a hyaline periderm, numerous angular spores. *Tetraspores* immersed in the ultimate segments, formed out of some of the superficial cells, triangularly divided.

This genus was founded by Dr. Greville on the *Fucus glandulosus* of the Banksian Herbarium, a little plant found along the European shores from the Coast of Ireland to the South of Spain, as well as in the Mediterranean Sea; and which possibly awaits discovery on the Atlantic shores of America. It closely resembles *Ceramium rubrum* in habit, but is evidently compressed, and much more opaque, the cortical layer being formed of several rows of coloured cells. To this original species I venture to add the two following from the Pacific Coast.

1. MICROCLADIA *Coulteri*; frond inarticulate, compressed, distichous, decompound-pinnate; branches alternate, elongate, simple, bi-tri-pinnate; pinnæ and pinnulæ plano-compressed, without evident articulation, the ultimate ramuli broadly subulate, acute; favellæ sub-globose or bilobed, sub-tended by two or three short ramuli. (TAB. XXXIII. A.)

HAB. California, *Dr. Coulter*. (v. s. in Herb. T. C. D.)

Frond six or eight inches long, half a line in diameter, compressed, becoming more so upwards, slightly flexuous, undivided or slightly divided, set throughout, at distances of half an inch, with lateral, undivided, virgate branches. These branches are erecto-patent, pinnated with shorter branches or pinnæ, half an inch to an inch or more in length; the lowest shortest, the rest successively longer to the middle of the branch, and thence again shorter to the apex. The pinnæ are plano-compressed, about bi-pinnate, all the divisions alternate and erecto-patent, the ultimate ramuli subulate and acute; the apical laciniae hooked inwards. No articulation is externally visible in any part of the stem or ramuli when examined with a microscope, but the internal articulated axial filament may be seen in some places with a pocket lens. A section of one of the upper branches shows a large central tube, surrounded by several series of polygonal cells; the inner large, the rest successively smaller to the circumference, which is formed of minute cells. A cross section of the base of the stem has a very different aspect: it exhibits a large central tube, though considerably shrunk from that of the branches, surrounded by one or more circles of large cells, separated from the central tube and from each other by

wide interstices filled with minute, filiform cellules. The stem does not readily recover its form when moistened after having been dried, and this structure, attempted to be shown in *fig. 5*, is not correctly given; the specimen from which it was drawn not having opened sufficiently. This difference in structure between the branches and stem originates in causes exactly similar to those that operate in some *Callithamnia*, in which the branches at first consist of a string of transparent-walled cells, but afterwards have their walls filled from above with filaments, issuing from the butts of the branches and gradually accumulating toward the base of the frond. The *favellæ* are formed on slightly shortened pinnules, and are roundish, subtended by two or four subulate ramuli. Colour a purplish red.

This is so similar to some varieties of *Ceramium cancellatum* that I had at first referred it to that species; but it is much more robust, more opaque, of a different internal structure, and moreover the pinnae and pinnulæ, which are lanceolate in circumscription, are alternately rather than dichotomously compounded.

Plate XXXIII. A. *Fig. 1.* MICROCLADIA *Coulteri*, the natural size. *Fig. 2*, a pinna; *fig. 3*, a pinnule with *favella*; *fig. 4*, a longitudinal, and *fig. 5*, a transverse section of the base of the stem (not quite correct); the latter figures more or less highly magnified.

2. MICROCLADIA *borealis*, Rupr.; frond inarticulate, distichous, dichotomo-secund, many times compounded; branches arched, virgate, set along their upper sides with numerous, secund pectinato-dichotomous, twice or thrice secundly compounded branchlets; ultimate ramuli incurved, acute; tetraspores in the ultimate ramuli, irregularly scattered. Rupr. *Alg. Ochotsk.* p. 259. *Microcladia scorpioides*, Harv. MS. in *Herb.*

HAB. Una Nootka, Dr. Scouler! Fort Vancouver, 1826, Garry! Unalashka, Wosnessenski! Golden Gate, California, Capt. Pike! (v. s. in Herb. T. C. D.)

Densely tufted. Fronds three to four inches long, as thick as hog's bristle, so closely coated with peripheric cells that no articulation is visible in any part of the frond without dissection. Internal structure as in the genus. The branches and all their subsequent divisions, though formed on a dichotomous type, appear from the nearly constant regular suppression of one of the arms of the bifurcation to be secund. The main branches are arched backwards, long and virgate, and closely set with falcato-secund, distichous secondary branches, from half an inch to an inch in length, and about a quarter inch apart. Each of these carries on its upper side five or six secund ramuli, which are again once or twice compounded in a similar manner. This order of ramification seems perfectly regular, without a trace of proliferous growth. Tetraspores are abundantly scattered through the surface cells of the ultimate ramuli in Capt. Pike's specimen.

This appears to be a very distinctly characterised species and to belong to the present genus, although it bears some external resemblance to *Ceramium obsoletum*,

Ag. It is much more opaque than that species, with a smaller axial tube and shorter articulations, and the ramification is as orderly as in *Plocamium coccineum*.

CENTROCERAS. Kütz.

Fronde filiform, dichotomous, articulated, corticated with oblong cells, arranged round the internode in longitudinal lines. *Favellæ* sessile on the branches, subtended by a few involucreal ramuli, and containing, within a hyaline periderm, many angular spores. *Tetraspores* formed by a transformation of some of the cortical cells, projecting from the surface, roundish, triangularly divided.

Plants with the external habit of *Ceramium*, from which genus this chiefly differs in having the cells of the cortical layer arranged in longitudinal, striæform rows, instead of being irregularly placed. Of the following species, which has many varieties, and is dispersed very widely through the Atlantic and Pacific Oceans, Prof. Kützinger has made no less than eight species.

1. *CENTROCERAS clavulatum*, Ag. ; frond capillary, rigid, dichotomous, fastigiate, at length proliferous from the axils ; apices hooked inwards, lower internodes four to six times as long as broad, upper successively shorter ; nodes armed with a whorl of minute spines ; tetraspores whorled round the nodes of the lesser branches and ramuli ; favellæ geminate, involucreate. *J. Ag. Sp. Alg.* 2, p. 149. *Centroceras sp. omnes*, Kütz. *Sp. Alg.* 688. (Tab. XXXIII. C.) β *crispulum*, Mont. ; filaments variously curved and twisted, and beset with lateral, squarrose ramuli, *Mont. Cuba. t.* 2, f. 1.

HAB. Abundant at Key West, on rocks, on the foundations of the Fort and elsewhere near low water mark, *W. H. H.* (both varieties), *Prof. Tuomey, &c.* (v. v.)

Fronde densely tufted, two to four inches long, as thick as human hair, nearly of the same diameter throughout, repeatedly and regularly dichotomous, the apices fastigiate ; branches straight and erect in var. α , variously twisted and spreading in β , naked, or furnished with lateral, proliferous, forked branchlets, which spring either from any node along the stem or often from the axils, especially the upper ones. *Fronde* articulated to the base ; the internodes in the lower part several times longer than broad, shorter above and very short towards the ends of the ramuli, coated with cells arranged in longitudinal striæform lines ; the cellules toward the apex of each internode short, quadrate, gradually longer toward the base, and

always longest in the older parts of the frond. The *nodes* are universally swollen, thicker than the internode above and below, each internode sitting in the one below it as in a little cup. In the young state each node is crowned with a whorl of minute spine-like processes, which are gradually obliterated in age, and are only to be found, in old plants, on the youngest branches. Young plants are also covered with copious, very slender hairs, afterwards deciduous. *Favellæ* subtended by three or four small branchlets. *Tetraspores* rather prominent, whorled round the nodes of the lateral ramuli. *Colour* a dark purple, passing into brick-dust-red in fresh water. *Substance* rigid and harsh. It does not adhere to paper in drying.

Plate XXXIII. C. *Fig. 1.* A tuft of *CENTROCERAS clavulatum*, the *natural* size. *Figs. 2 and 3,* portions of filaments of different ages; *fig. 4,* apex of a branch; *fig. 5,* internodes of the stem; all more or less *magnified*.

III. CERAMIUM. *Lyngb.*

Frond filiform, dichotomous or somewhat pinnate, articulate; the articulations either partially or wholly coated by small cells not arranged in lineal series. *Favellæ* sessile on the branches, subtended by a few involucreal ramuli, and containing, within a hyaline periderm, many angular spores. *Tetraspores* formed by a transformation of some of the cortical cells, more or less projecting from the surface, roundish, triangularly divided.

The fronds generally grow in dense tufts, seldom exceeding six inches in height, and often not half that measurement. The stems vary in diameter from the thickness of a hog's bristle, or rather more, to the fineness of a cobweb. Some species are so completely corticated with minute coloured cellules as to be nearly opaque; others are beautifully variegated with hyaline and coloured bands alternately placed; the coloured or corticated portion of each cell being that nearest to the node, the hyaline band occupying the central region of the internode. Many of the species, perhaps all, are, when young, clothed at the nodes with very fine, soft, hyaline hairs, which, as the frond advances in age, fall away, leaving the articulation quite smooth. Other species are armed at the nodes with thorn-like processes or prickles, but none of this section have yet been found in North America.

The number of *book*-species has been largely increased of late years, partly by the discovery of new forms, and partly by splitting into several the *specific ideas* (so to say) of the older botanists. Some of these newly proposed species are no doubt proper to be retained, but I fear the splitting process has been carried far beyond its legitimate limits. The North American species naturally divide into two sections, in the first of which the cortical cells cover over either the whole of the

articulation or the greater portion of it; in the second, they are confined to a definite band surrounding the nodes.

SECT. 1. RUBRA; *Frond unarmed (not spinuliferous); the stratum of cortical cells decurrent from the nodes, and more or less completely clothing the surface of the internode.*

1. CERAMIUM *nitens*, J. Ag.; frond subsetaceous, slightly attenuated upwards, irregularly dichotomous, diffuse, the branches widely spreading and divaricating; upper branches zig-zag, with lateral, distant, frequently secund branches and ramuli; ultimate ramuli scattered, subulate, straight at the point; internodes clothed with cells on all parts of the frond, the lower ones twice as long as broad, the upper very short. *J. Ag. Sp. Alg.* 2, p. 130.

HAB. At Key West, Florida, *W. H. H., Prof. Tuomey*, No. 18, (v. v.)

Frond four to eight inches long, not so thick as hog's bristle, dichotomously branched from the base, all the divisions very patent, often spreading at right angles, and sometimes with still greater divergence. The upper forks are equally wide with the lower, but are less regular; one arm of the dichotomy being frequently shortened to a branchlet. Thus the ramification becomes as it were alternately zig-zag or secund. Ramuli few or many, filiform, simple, acute, not forcipate at the extremity, distant and very patent. *Substance* rather firm. *Colour* a full red or brownish. *Fruit* unknown. *Internodes* uniformly coated with small cells, not much or at all contracted at the nodes.

I have not seen specimens of Agardh's plant, and may be wrong in the above reference. But be this as it may, I have no hesitation in regarding the plant here described as a distinctly marked species, differing from *C. rubrum* not merely in ramification, but essentially in structure. If cross sections of both plants be compared together under the microscope, the differences may be readily seen. In our *C. nitens* the walls of the monosiphonous frond are very thick, and the peripheric cells are set within the pellucid substance of the wall in dichotomous, radiating, horizontal series, whose apices constitute the superficial coating. In *C. rubrum* the surface cellules are of large size, not disposed in radiating lines, and a circle of empty, polygonal cells surrounds the central tube, as in *Microcladia*.

2. CERAMIUM *rubrum*, Ag.; frond robust, setaceous, gradually attenuated, dichotomous, sub-fastigiate, with or without lateral simple or forked ramuli; segments erecto-patent, the apices either slightly incurved or hooked; lower internodes twice or thrice as long as broad, contracted at the nodes, more or less densely covered with surface cellules; favellæ lateral, subtended by three or four short ramuli; tetraspores distributed round the nodes. *J. Ag. Sp. Alg.* 2, p. 127. *Kütz. Sp. Alg.*

p. 685. *Harv. Phyc. Brit.* t. 181. *Conferva rubra*, *E. Bot.* t. 1166. *Dillw. Conf.* t. 34.

β decurrens; the younger internodes naked in the middle, the older gradually covered over with cellules; frond either regularly dichotomous or furnished with lateral, forked ramuli. *Ceramium decurrens*, Kütz. *Sp.* p. 675. *Harv. Phyc. Brit.* t. 276.

γ proliferum; internodes densely covered with cells; frond dichotomous, beset on all sides with numerous, lateral, simple or forked branchlets. *Ceramium botryocarpum*, Griff.—*Harv. Phyc. Brit.* t. 215.

δ secundatum; similar to var. *γ*, except that the ramuli are very generally secund. *Cer. secundatum*, Lyngb. *Hyd. Dan.* t. 37, A.

ε squarrosum; frond of small size, regularly dichotomous, fastigate, with very few and short lateral ramuli; lower forks distant, with patent axils; upper very close together, very patent, the segments divaricating and apices sometimes revolute.

HAB. Pacific Coast. Atlantic Coast from the Arctic Sea to Charleston, South Carolina. *β*, Prince Edward's Island, *Dr. Jeans*. Halifax, *W. H. H.* New Bedford, *Dr. Roche*. *γ*, Newport, *Prof. Bailey*. *δ*, Newfoundland. *ε*, growing on *Zostera*, Boston Harbour, *Mr. G. B. Emerson*. Lynn, *Mrs. Mudge*. (v. v.)

Frond two to ten inches long, thicker than hog's bristle below, attenuated upwards and capillary in the ultimate ramuli, pretty regularly dichotomous; the lower forks distant, the upper approximated, with rounded axils and erecto-patent slightly converging segments. Young specimens are generally simply dichotomous; older ones have often numerous lateral ramuli, half an inch in length, simple or forked. Sometimes these are very numerous, as in vars. *γ* and *δ*. In var. *β*, the stem and branches are beautifully variegated with alternate pale and coloured bands. In the other varieties the internodes are uniformly coloured. Our var. *ε* is a very remarkable form, two to three inches high, fastigate, with very patent squarrose ramification. It almost looks like a distinct species, but seems traceable through varying specimens into the common form. *Colour*, varying through nearly every shade of red to orange, yellow, dirty white or greenish.

Many more varieties than those above enumerated occur on our coasts. The above are, however, the most distinctly marked.

SECT. 2. DIAPHANA; *Frond unarmed (not spinuliferous); the stratum of cortical cells confined to a definitely limited band round the nodes; the internodes diaphanous.*

3. CERAMIUM *Hooperi*; fronds rising from creeping surculi, densely matted below, erect, capillary, irregularly dichotomous; ramuli scattered, erect, subulate, straight, or slightly curved, (the ends of the branches frequently bearded at one side with a series of thick, root-like fibres, one rising from every node); articulations in all parts of the frond of equal length and breadth, the internode formed of

a single, naked, coloured cell; the node coated with a definite band of large cellules.

HAB. On perpendicular rocks, densely covered with Fuci, near low-water mark. Camden, Penobscot Bay, *Mr. J. Hooper*. Newburyport, *Capt. N. Pike*. (v. s. in Herb. T. C. D.)

This spreads over the surface of the rock in dense, root-like patches. The filaments are an inch or two in height, possibly more in full-grown specimens, irregularly dichotomous, and furnished with scattered, lateral ramuli, which are either straight, or slightly curved at the point. The stems spring from a mat of confervoid fibres; near the base the cortical layer of the nodes is very narrow, the internode being formed of a single, thick-walled cell, containing a dark purple endochrome. The nodes in the upper part of the filament have a wider, but always a strictly defined band of cortical cells, and the internodes throughout the filament consist of a single large cell filled with endochrome. Most of the branches in Mr. Hooper's specimens throw out from several of the nodes, below the tips, a number of secund, hyaline, root-like filaments, one-fourth of the diameter of the part from which they spring, one rising from the marginal cell of each node. *Fruit* at present unknown.

I have the more pleasure in naming this curious plant after its discoverer, Mr. J. Hooper of Brooklyn, because I believe it to be distinctly marked by the structure of its articulations, as well as by its creeping habit. The bearded extremities of the branches afford a very unusual character, but I fear to ground a diagnosis on them, as they do not occur in a specimen from Capt. Pike, which differs in no other respect from those collected by Mr. Hooper.

4. *CERAMIMUM diaphanum*, Roth; filaments setaceous, attenuated upwards, rather flaccid, irregularly dichotomous; the branches set with short, lateral, dichotomous ramuli; internodes colourless, those of the main stems three or four times as long as broad, of the ramuli short; nodes swollen, coated with a definite band of purple cellules; favellæ near the ends of the branches or of small ramuli; tetraspores numerous in each node. *J. Ag. Sp. Alg.* 2, p. 125. *Harv. Phyc. Brit.* t. 193. *Hormoceras diaphanum*, Kütz. *Sp. Alg.* p. 675. *Conferva diaphana*, E. Bot. t. 1742. *Dillw. Conf.* t. 38.

HAB. Boston Bay, *Dr. Durkee*. Nahant, *Mrs. Mudge*. New Bedford, *Dr. Roche*. Providence, *Mr. Olney* and *Prof. Bailey*. New York Bay, *Messrs. Hooper, Walters, Pike, Calverley, &c.* Key West, *Mr. Binney, Dr. Blodgett, W. H. H.* (v. v.)

Fronde two to four inches high, variable in diameter, as thick as hog's bristle or as horse hair below, gradually attenuated upwards and nearly capillary above, irregularly dichotomous, with many lateral, dichotomous branchlets of various lengths; apices rarely fastigiate, but more so in some varieties than in others.

Ultimate ramuli forcipate at the apex. Sometimes the lateral branches are few, simply forked, and distantly scattered along the branches, either alternate, or secund; sometimes they are very numerous, springing from nearly every node. *Internodes* hyaline, destitute of cortical cells, those of the lower branches three or four times as long as broad, the upper ones successively shorter. *Favellæ* involucrate, mostly sessile near the ends of the lateral ramuli. *Tetraspores* either in the ramuli or the main branches, densely whorled round the node, prominent. *Colour* of the tuft a dark purple. *Substance* soft, adhering to paper in drying.

5. *CERAMIMUM subtile*, J. Ag.; "frond capillary, dichotomous, sub-alternately branched above, branches elongate, set with patent, forcipate ramuli; lower internodes twice or thrice as long as broad, upper successively shorter; nodes scarcely swollen; tetraspores secund on the outer edge of the segments, rather prominent." *J. Ag. Sp. Alg.* 2, p. 120.

HAB. Vera Cruz, Gulf of Mexico, *Liebman*.

Said to be allied to *C. gracillimum*; but is of greater diameter, with more patent, by no means fastigiate ramuli, shorter lower articulations, less swollen nodes, and differently disposed tetraspores. I have not seen any specimens.

6. *CERAMIMUM tenuissimum*, Lyngb.; frond capillary, of equal diameter throughout, rigid, dichotomous, excessively divided, fastigiate; the axils very patent; internodes colourless, those of the middle of the stem from four to six times as long as broad, the upper successively shorter; nodes swollen; tetraspores very prominent, secund on the outer edge of short lateral ramuli, one or more at each node; favellæ involucrate, near the tips of short ramuli. *J. Ag. Sp. Alg.* 2, p. 120. *Ceramium nodosum*, Harv. *Phyc. Brit.* t. 90. *Gongroceras nodiferum*, Kütz. *Sp. Alg.* p. 678, also *G. tenuissimum*, Kütz. l. c. p. 680.

HAB. Key West, Florida, *W. H. H.*, *Prof. Tuomey*, *Mrs. Adams*. Key Biscayne, *Prof. Tuomey*. (v. v.)

Tufts two to three inches long, globose, fastigiate. *Filaments* much finer than human hair, many times dichotomous with very patent angles and spreading branches and ramuli. *Apices* diverging, forcipate. The lower forks are distant, the upper gradually nearer. The lateral ramuli are either simple or forked, hooked in or forcipate at the ends. They bear the fructification of both kinds. *Colour*, a pale or dark purplish red, changing to ferruginous-red in fresh water. *Internodes* of the ramuli very short, of the lower branches successively longer, and 5—6 times as long as broad in the lower part of the plant. Nodes generally swollen.

The American specimens here described are destitute of fruit, and are so far, therefore, uncertain; but in other respects are very similar to European specimens.

7. *CERAMIMUM fastigiatum*, Harv.; frond capillary, of equal diameter throughout, flaccid, dichotomous, level-topped; the axils acute; internodes pellucid, the lower ones nearly colourless, from four to six times as long as broad, the upper successively shorter, and filled with pale rose-coloured endochrome; nodes banded; favellæ sub-terminal, involucreted; tetraspores prominent, secund on the outer edge of the branches. *J. Ag. Sp. Alg.* 2, p. 119. *Harv. Phyc. Brit. t.* 255. *Gongroceras fastigiatum*, Kütz. *Sp. Alg.* p. 678.

HAB. Massachusetts Bay, *Dr. Durkee, Captain Pike*. Greenport, *W. H. H. Newport, Prof. Bailey, Mr. Olney, &c.* Longbranch, New Jersey, *Miss Morris*. (v. v.)

Tufts very dense, fastigate, soft. *Filaments* finer than human hair, many times regularly dichotomous, the lower axils sub-distant, the upper gradually nearer, not widely spreading. Apices of all the branches generally on a level, the ultimate divisions forcipate. Occasionally there are a few lateral ramuli. Internodes pellucid, but suffused with a pale blush, the uppermost ones filled with rosy endochrome. *Nodes* coated with a definite band of small cells. General colour of the tuft a bright lake-red, becoming in fresh water first scarlet and then orange.

The American specimens are very similar to those from the South of England and Ireland.

8. *CERAMIMUM arachnoideum* (?) Ag.; tufts fastigate, dense; filaments capillary, attenuated upwards, many times regularly dichotomous; axils more or less patent, the lower distant, the upper close; apices forcipate, not strongly inflexed; internodes pellucid, the lower ones thrice or four times as long as broad (sometimes veiny), upper very short; favellæ lateral, subtended by elongating ramuli (at length axillary); tetraspores bursting from the outer edge of the nodes, especially of the upper branches, solitary or aggregated, very prominent. *J. Ag. Sp. Alg.* 2, p. 117. *β patentissimum*; of small size, the lower furcations distant and very patent; the branches ending in dichotomo-multifid, divaricating, corymboso-fastigate ramuli; internodes of the ramuli extremely short. (TAB. XXXIII. B.)

HAB. Boston Bay, *Dr. Durkee, Capt. N. Pike*. Newhaven, *Mr. J. Hooper*. Bay-side, New York Bay, *Mr. J. Hooper*. Hellgate, *Mr. Walters*. Var. *β*, Boston Bay, *Dr. Durkee and Capt. N. Pike*. New York Harbour, *Mr. Walters and Mr. Hooper*. (v. s. in Herb. T. C. D.)

Fronde very dense, one to two inches in diameter, fastigate. *Filaments* rather thicker than human hair below, attenuated to the extremity, many times regularly dichotomous, the lower forks distant and rather patent, the upper successively closer and (except in var. *β*) more erect; the apices forked and slightly forcipate, sub-obtuse. *Nodes* coated with a band of cells, not swollen, sometimes constricted; lower internodes hyaline or occasionally striated with coloured, cobweb-like filaments which run through the walls, now and then anastomosing; upper inter-

nodes very short, not swollen, except the fertile ones. *Favellæ* lateral on the upper branches, not on lateral ramuli, subtended by two or three ramuli which at first are short, but afterwards lengthen and divide dichotomously, and then the favellæ seem sitting in a nest of branches. *Tetraspores* large and very prominent, bursting singly or in clusters from the outer margin of the nodes, especially those of the upper divisions. *Colour*, a brownish purple. *Substance*, flaccid, adhering to paper. Our var. β is a very remarkable form, and at first I looked upon it as a distinct species, but a further comparison of numerous specimens leads me to regard it as being merely an extreme variety. I have received it from several correspondents.

The reference to Agardh, whose plant comes from the Baltic Sea, requires confirmation, as I have seen no authenticated specimen. As a species our American plant is allied to *C. diaphanum*, from which it differs in size and in the mode of fruiting; and to *C. fastigiatum* and *tenuissimum*, from which the shorter internodes, unswollen nodes and more robust filaments separate it.

Plate XXXIII. B. *Fig. 1.* CERAMIUM *arachnoideum*, β *patentissimum*; the natural size. *Fig. 2*, part of a branch, *magnified*. *Fig. 3*, some of the nodes and internodes, highly *magnified*.

9. CERAMIUM *byssoides*; filaments exceedingly slender ($\frac{1}{800}$ of an inch in diameter), soft, dichotomous; forks distant below, approximate above, the branches erecto-patent with acute angles; the upper branches having a few level-topped, forked, lateral ramuli; internodes hyaline, those of the principal stems six or eight times as long as broad, of the lesser thrice as long as broad, of the ramuli very short; internodes banded, definite, swollen, especially the upper ones; fruit unknown.

HAB. Parasitical on Gorgoniæ, at Key West, W. H. H. No. 77. (v. v.)

Tufts about an inch high, exceedingly soft. *Filaments* of almost cobwebby fineness, repeatedly and pretty regularly dichotomous, the axils all narrow and angles acute. Lateral ramuli on my specimens few. *Nodes* of the ramuli greatly swollen, bead-like, much thicker than the internode; those of the older branches less so, dark purple. *Colour* of the tuft rather pale.

This is by much the most slender of the genus. *Cer. gracillimum*, when placed beside it on the table of the microscope, looks large and coarse in comparison; nor is there the difference in diameter between the main branches and the ramuli, so observable in that species.

IV. PTILOTA. *Ag.*

Frond cartilaginous, compressed, two-edged, decompound, pectinato-pinnate, distichous, opaque, having an articulated, monosiphonous axis enclosed in a thick

cortical stratum of cells ; the inner cells of the cortical layer roundish, the outer minute, coloured. *Favellæ* terminal on the lesser ramuli, involucreted with numerous ramelli, containing within a hyaline periderm, numerous angular spores. *Tetraspores* on the ultimate pinnules, external, sessile, solitary or aggregate, formed each from an internode of the ramulus, roundish, triangularly divided.

A beautiful genus, strongly marked by its decompound-pinnate, distichous, inarticulate, or, rather, internally articulate fronds, which are of larger size, firmer texture and more opaque than in most other genera of this Order. All are branched on a pinnate model. In some the pinnæ and pinnulæ are regularly alternate throughout the branches and lesser divisions. In others they are as regularly opposite ; but among those with opposite pinnæ two varieties of ramification must be carefully distinguished. In some the opposite pinnæ are of the same nature, either of equal length and exactly similar, or one longer than the other, a longer and shorter pinna alternating regularly at each side of the rachis. In others, the opposing pinnæ are of different natures ; one of them phyllodium-like, always remaining unchanged after having once been formed, either entire, serrate or pectinate ; the other branch-like, pinnately-compound, at first shorter and simpler, afterwards lengthened and decompound in similar manner to the larger branches of which it is a pinna. The pinnæ opposite the phyllodia are often abortive or little developed ; whence arises an irregularity of ramification in most species. Often too they are very much reduced in size and converted into racemes of fructification.

SECT. 1. DIVERSIFOLLE : *Pinnæ* opposite, of different nature, one leaf-like undivided, the other (sometimes obsolete) branch-like, pinnately-compound.

1. *PTILOTA densa*, Ag. ; frond plano-compressed, two-edged, decompound pinnate ; pinnæ opposite, unlike ; one undivided, falcate, inciso-pectinate along its outer edge ; the other compound, either lengthening out into a branch, or minute and ramuliform ; branches linear, densely set with the falcate pectinifid pinnæ and opposing minute multifid ramuli ; tetraspores in oblong glomerules alternating with the pinnulæ of the multifid ramuli. *J. Ag. Sp. Alg.* 2, p. 98. · *Ptilota pectinata*, Harv. in *Beech. Voy.* p. 164. (TAB. XXXII. B.)

HAB. California, *Lay and Collie.* (v. s. in Herb. T. C. D.)

Frond several inches long, half a line in diameter, more or less compressed, decompound-pinnate, but very irregular in the development of its major pinnæ, though perfectly regular in the system of construction. Sometimes the major pinnæ are closely set and furnished with a second or third series also closely placed together ; sometimes (as in the specimen we have figured) they are widely distant and very unequal in length. Both the larger and lesser branches are opposed, at

their insertion, to falcate, incurved, leaf-like ramuli, a line or two in length, pectinate or deeply inciso-dentate along the outer edge. Similar distichous pinnæ border all the branches at distances of a line or two apart, alternating with each other, but opposing minute, multifid ramuli of equal length or very much shorter. These ramuli, carelessly examined, appear to be mere heads of densely crowded divaricato-multifid ramelli; but are really composed on the same pinnated type as the rest of the frond, one pinnule being falcate and pectinate, the other pinnato-multifid, or if fertile, altered into a glomerulus of tetraspores. *Colour*, a full red, brownish when dry. *Substance* rigid, not adhering to paper.

A very remarkable and distinct species. I have examined an authentic fragment of Agardh's *P. densa*, preserved in Sir Wm. J. Hooker's Herbarium, and find it to agree perfectly with my more recently named *P. pectinata*. The latter name is therefore suppressed.

Plate XXXII. B. *Fig. 1.* *PTILOTA densa*; the natural size. *Fig. 2.* portion of a branch, with pectinate pinnæ, and opposing multifid, fertile ramuli; *fig. 3.* a ramulus, with clusters of tetraspores; *fig. 4.* tetraspores; the latter figures more or less magnified.

2. *PTILOTA hypnoides*, Harv.; frond plano-compressed, two-edged, decompound-pinnate; pinnæ opposite, unlike; one undivided, leaf-like, lanceolate or ovato-lanceolate, acute, very entire; the other elongated, pinnated with similar lanceolate acute pinnæ opposing ramuliform processes; tetraspores aggregated in oblong glomerules, alternating with the pinnules of the lesser branches. *Harv. in Bot. Beech. p. 164. J. Ag. Sp. Alg. 2, p. 97. Kütz. Sp. Alg. p. 670. (TAB. XXXII. A.)*

HAB. California, *Messrs. Lay and Collie.* (v. s. in Herb. T. C. D.)

Fronde six to eight inches long, or probably much more, half a line in diameter at the base, compressed, two-edged, decompound-pinnate; the primary branches of very unequal lengths, long and short intermixing together, closely pinnated throughout at distances of a line or two. One of the pinnæ is a simple, leaf-like, lanceolate or ovato-lanceolate, acute ramulus, a line in length, never altering with age; the opposite pinna is a branchlet which is either abortive and rudimentary, or lengthens out into a branch which is closely pinnated with lanceolate leaf-like pinnules (like those of the larger branches) opposed to minute, pinnulated branchlets of their own length or shorter. These latter occasionally elongate, and are compounded in a similar manner to the larger branches; and thus the frond continues to be developed. When fertile, however, they remain short, and consist then of lanceolate pinnellæ alternating with stalked, oblong clusters of tetraspores. *Colour*, a rosy purple. *Substance*, cartilaginous and firm. In drying, it does not adhere to paper.

A beautiful species, and perhaps not rare; but as yet very few specimens have found their way to Europe. It was first found by Hænke, whose specimens were

confounded by the elder Agardh with *P. asplenioides*, from which this species is abundantly distinct.

Plate XXXII. A. *Fig. 1.* *PTILOTA hypnoides* ; the *natural* size. *Fig. 2*, portion of a larger and lesser branch, with fertile ramuli ; *fig. 3*, a fertile ramulus, with oblong clusters of tetraspores ; *fig. 4*, tetraspores ; *fig. 5*, transverse section of the base of the stem ; the latter figures more or less highly *magnified*.

3. *PTILOTA asplenioides*, Ag. ; frond plano-compressed, two-edged, decompound-pinnate ; pinnæ opposite, unlike ; one undivided, serrulated, the other (abortive or) pinnately parted ; pinnulæ erecto-patent, decurrent, scymitar-shaped, incurved, acute, serrulate, areolate ; fruits marginal, supra-axillary, the tetraspores in dense, roundish, pedicellate glomeruli ; the favellæ involucrate, the branches of the involucre pinnellated with articulate, single-tubed ramelli. *J. Ag. Sp. Alg.* 2, p. 98. *Rhodocallis asplenioides*, Kütz. *Sp. Alg.* p. 674. *Fucus asplenioides*, Turner, *Hist. Fuc.* t. 62. *Esper. Ic.* t. 147.

HAB. Northern Pacific Ocean. Prince William Sound, Russian America, *Mr. Menzies*. (v. s. in Herb. T. C. D.)

Frond twelve to eighteen inches long, a line or more in breadth, with a strongly compressed stem, which is slightly winged above, two-edged below, very firm, opaque and cartilaginous in its lower part, gradually flatter and thinner toward the summit, single or divided into several principal branches or secondary fronds. The mode of branching is pinnate ; the pinnation repeated many times in large specimens after a uniform system, which is easily understood by examining one of the lesser branches of an old plant, or the apex of the main stem in a younger plant. Such branch has a plano-compressed rachis, distichously pinnate with normally opposite, but very different looking pinnæ. One pinna of each pair is undivided, about two lines long and half a line wide, cultriform, acute, erecto-patent and somewhat incurved, more or less distinctly serrated or serrulated, rarely nearly entire, its lamina vertical (in the same plane as the flat rachis) the lower edge decurrent or gradually fining off into the rachis. The opposing pinna when developed, for it is frequently abortive, is many times longer and is again pinnated on a similar plan. In the subsequent divisions of the frond the undivided-cultriform pinnæ and pinnules are often alone perfected, and these constantly alternate with each other ; the place of the pinnately-parted pinnæ being merely indicated by a minute ramulus or even reduced to a rapidly obliterated process. In such specimens the frond seems alternately pinnatifid, as figured and described by Turner, but the examination of a young branch shows that this is a deceptive appearance. The pinnæ and pinnulæ are coated with a uniform surface of small polygonal cells. When held between the eye and the light, and examined with a pocket lens, a slender medial line (the axial filament) is seen running through the frond, and sending off branches to each pinnule ; this line of cells, in the pinnule, running nearer to the upper than to the inferior margin. The serratures of the margin are very variable

in different specimens. *Fruit* of both kinds is borne along the margin, either on the rachis, above the axil of the pinnules, or, very frequently, along one or both edges of the pinnule itself. The *tetraspores* are densely crowded in little pedicellate heads. The *favellæ* are likewise stalked, and surrounded by involucral pinnated ramelli. *Colour*, a dark brownish red. *Substance*, cartilaginous. It does not adhere to paper in drying.

Discovered by Mr. Menzies on the North West Coast of America, but seemingly much more common in North Eastern Asia, particularly in Kamtschatka, from which country I possess several specimens.

4. *PTILOTA Californica*, Rupr. ; frond plano-compressed, two-edged, virgate, decompound-pinnate ; pinnæ and pinnulæ opposite, unlike ; one undivided denticulate or serrate, the other (abortive or) pinnately parted ; pinnulæ broadly sword-shaped, slightly narrowed at base, erecto-patent, incurved, acute, more or less denticulate, especially toward the apex, areolated with cells ; fruits marginal, the tetraspores (?) in densely paniculate, pedicellate glomeruli alternating with the pinnulæ ; favellæ similarly placed, involucrate, the branches of the involucre entire or dentate. *β concinna* ; pinnules sharply inciso-serrate.

HAB. North California, *Wosnessenski!* Golden Gate, *Capt. Pike!* Var. *β*, with the preceding, *Capt. Pike.* (v. s. in Herb. T. C. D.)

Fronde six or eight inches long, repeatedly pinnate, the primary and secondary pinnæ long and virgate, the rest short, ramuliform. Branches strongly compressed, half a line wide, erecto-patent, much attenuated at their insertion. *Pinnulæ* between lanceolate and sword-shaped, slightly narrowed, not the least decurrent at base, incurved, acute, sometimes almost entire, but generally sharply denticulate, or unequally serrate. *Favellæ* pedicellate, marginal, solitary or numerous in the spaces between the pinnules. *Tetraspores* appear to occupy the same place, but I have not seen perfectly formed ones : in my specimens there are minute, paniculately branched glomeruli, but whether intended for antheridia or tetraspores I have not determined. *Colour*, dark purple-red.

This species is very nearly allied to *P. asplenioides*, from which it chiefly differs in the narrower, not decurrent pinnules, evidently narrowed at the base. It differs from *P. serrata* more in its virgate habit and dark colour than by any very precise characters, unless that noticed in the glomeruli of tetraspores may be constant. The serratures of the pinnulæ are exceedingly variable, each of Capt. Pike's specimens differing in the degree of incision.

5. *PTILOTA serrata*, Kütz. ; frond plano-compressed, two-edged, decompound-pinnate ; pinnæ and pinnulæ opposite, unlike ; one undivided serrated, the other (abortive or) pinnately parted ; pinnulæ broadly subulate, very patent, acute, sharply serrated, especially on the outer edge, areolated with cells ; fruits marginal,

the tetraspores in conical, pedicellate glomeruli, alternating with the serrated pinnulæ; favellæ similarly placed, involucrate, the branches of the involucre entire or coarsely toothed, cellular. *Kütz. Bot. Zeit.* 1847, p. 36. *J. Ag. Sp. Alg.* 2, p. 96. *Ptilota plumosa* β *asplenioides*, *Lyngb. t.* 9, f. 2. (*Excl. Syn.*)

HAB. Pacific Coast at Sitcha, *Ruprecht*. Greenland and Newfoundland, *J. Agardh*. Arctic Coast, *Sir John Richardson*. Halifax, *W. H. H.* Boston Bay, *Dr. Asa Gray*, *Mrs. Mudge*, *Mr. Emerson*, *W. H. H.*, &c. (v. v.)

Frond four to six inches long, the stem plano-compressed, half a line in breadth, distichously much branched, the branches decompound-pinnate, all divisions of the frond very patent, almost issuing at right angles. *Pinnæ* and pinnulæ of every series exactly opposite, except by accidental suppression, but of different size and aspect: one of each pair a line long, horizontal, broadly subulate, sharply serrated especially on the outer edge, acute, seldom lengthening and never much lengthened, in the older parts of the frond generally broken, or worn: the other pinna elongate, pinnated and lengthening out into a branch which becomes again compounded by its pinnæ also lengthening in a similar manner. In this way the frond finally consists of several series of short-serrated, and of longer-pinnated opposing pinnæ. The *favellæ* are formed in the apices of the pinnated (or compound) ramuli, which are then abbreviated to a line or two in length; the branches of their involucre are subulate, either entire or with three or four coarse teeth. *Tetraspores* in dense conical heads, also formed from suppressed branches, alternating with the serrated pinnæ. *Substance*, cartilaginous. *Colour*, a deep, full red, becoming brighter in fresh water. In drying, it does not adhere to paper.

This has the colour, size, and general aspect of *Pt. plumosa*, with which I have been hitherto accustomed to unite it, nor am I very certain that the characters here pointed out as distinguishing it are to be relied upon as sufficient. The strongest character will perhaps be found in the tetrasporic fruit: that in the ramification is, I fear, less constant. The elder Agardh at one time, and Lyngbye both referred it to *Pt. asplenioides*, from which it is readily distinguished. Agardh afterwards made it a variety of *Pt. plumosa*. Kützing in 1847 first gave it a specific name, but subsequently, in 1849, reduced it again as a variety, under *Pt. plumosa*. Professor J. Agardh, however, restores the species, and points out with his usual acumen the characters by which it may be known from *Pt. plumosa*.

These characters, so far as they depend on ramification, are not perfectly satisfactory to me, for I find the serrated ramuli of *Pt. serrata* showing an occasional disposition to lengthen into branches; and again, on *Pt. plumosa* one of the opposing ramuli is, in the younger branches, frequently abortive, in which case the ramuli are alternately unequal, as in *Pt. serrata*. If the ramulus which is formed were always clearly pinnated as it ought to be in *Pt. plumosa*, there would be no doubt of the validity of *Pt. serrata*; but though this is commonly the case, yet I have specimens of the former species in which slightly serrated, or nearly entire ramuli alternate with pinnated ones in some parts of the frond. Both species occur together in Norway, but *Pt. serrata* has not yet been found in Britain. Almost all the

American specimens before me are clearly referable to *Pt. serrata*; nevertheless, Sir John Richardson collected on the Arctic coast both the true *Pt. plumosa* and *Pt. serrata*. Finally, and this is rather puzzling, I have a specimen from Prince Edward's Island somewhat intermediate in character between both species, but having the preponderance in favour of *Pt. plumosa*, and yet being unlike any European specimen of that species which I have seen.

On the whole I am disposed, for the present, to adopt this species, considering it more critically characterised in doubtful cases by its fructification than by its ramification.

SECT. 2. SIMILIFOLLÆ: *Pinnæ opposite, of similar nature, either both of the same length or one longer, one shorter than the other; the longer alternating on the rachis.*

6. *PTILOTA plumosa*, Ag.; frond plano-compressed, two-edged, decompound pinnate; pinnæ and pinnulæ opposite, similar in form, but one frequently shorter than the other, the shorter pinna simply pinnate, not altering; the longer developing into a branch, becoming compound; ultimate pinnated ramuli, by suppression of the opposing ramuli, frequently alternate; pinnellæ subulate, arcolated with cells, acute; favellæ formed either on the pinnæ or pinnellæ, involucrate, the branches of the involucre subulate, entire; tetraspores on marginal processes of the pinnellæ. *J. Ag. Sp. Alg.* 2, p. 96. *Harv. Phyc. Brit. t.* 80. *Fucus plumosus*, L.—*Turn. Hist. t.* 60. (*excl. var. β.*), *E. Bot. t.* 1308.

HAB. Parasitical on the stems of *Laminariæ*, &c. Prince William's Sound, North West America, 1787, *Mr. Menzies*! Arctic Sea Coast, *Sir John Richardson*! Prince Edward's Island, *Dr. Jeans*. (v. v.)

Very like the preceding in aspect, and only to be known by the characters detailed in the above descriptions and remarks. The different position of the *tetraspores* is perhaps the most valid character.

The true *Pt. plumosa* is of very rare occurrence in America. That which commonly passes under this name, in collections made to the North of Cape Cod, is *Pt. serrata*; that in those made to the south of that head-land is *Pt. elegans*. I have examined and compared specimens of the true *Pt. plumosa* from the above localities, with European individuals, and consider them specifically identical.

7. *PTILOTA elegans*, Bonnem.; frond flaccid, filiform, terete, decompound-pinnate; pinnæ and pinnulæ opposite, similar, both pinnately parted, the opposing one either of equal size or one smaller than the other; the younger pinnæ and all the ultimate pinnules articulate, composed of a single series of large, sub-quadrate cells, obtuse, linear (not attenuated); tetraspores terminating the ramuli, at length polysporous; favellæ binate, naked, or sub-involucrate, on the pinnæ. *Bonnem. Hydr. p.* 22. *Kütz. Phyc. p.* 378. *J. Ag. Sp. Alg.* 2, p. 94. *Pt. sericea*, *Harv. Phyc. Brit. t.* 191.

HAB. Generally on rocks, rarely on the stems of the littoral Fuci. Boston Bay, at Beverley, *W. H. H.* Newport, *Prof. Bailey, Mr. Olney, &c.* Squan Beach, New Jersey, *Miss Morris.* (v. v.)

Fronde three to six inches long and as much in the expansion of the branches, as thick as hog's bristle at the base, attenuated upwards, terete, not compressed or two-edged, decompound-pinnate; the larger branches irregularly alternate and of unequal length, the lesser close together, opposite, either of equal length or one of each pair short, the other longer and more compound. The lesser branches are linear-oblong or somewhat obovate in outline, their upper subdivisions being successively longer than the lower; they are twice or thrice pinnated. All the divisions, except by suppression, are strictly opposite, but towards the extremities one of the opposing pinnæ is often imperfectly formed. The pinnules and all the younger pinnæ are articulate, composed of a single row of large, quadrate or slightly oblong cells; they are slightly incurved, of equal diameter throughout, very obtuse, and those along the outer edge of the rachis are generally longest, and are frequently pinnellated at the tips. *Tetraspores* borne on the tips of the ultimate pinnules, at first containing four sporules, afterwards eight or a larger number, when they resemble favellæ. *Colour* a brownish purple, rather dark; a clear purple-lake under the microscope. *Substance* soft. In drying, it closely adheres to paper.

A smaller and softer plant than any of the preceding and readily known by its articulated pinnules.

V. CROUANIA. *J. Ag.*

Frond filiform, gelatinous, nodoso-moniliform, alternately decompound, consisting of an articulated, monosiphonous primary filament (or axis) emitting at the nodes densely whorled, minute, dichotomo-fastigiate, gelatinous, free ramelli. *Favellæ* near the ends of the branches sub-solitary, affixed at the base of the whorled ramelli and covered by them, containing, within a hyaline periderm, numerous roundish spores. *Tetraspores* fixed at the base of the ramelli, partly hidden by them, roundish, triangularly parted or transversely bi-parted.

Very flaccid, gelatinous Algæ of small size with moniliform branches, resembling in habit the species of the fresh water genus *Batrachospermum*. In artificial character they nearly coincide with the species of *Halurus*, but differ essentially in the position of the fructification, and in the substance of which the frond is composed. The young branches are nearly cylindrical, the whorled ramelli forming a scarcely interrupted periphery. As the frond increases in age, the whorls are

removed further apart by the elongation of the internodes, and the branches become beaded at intervals.

1. *CROUANIA attenuata*, J. Ag.; frond attenuated upwards; the tetraspores solitary, triangularly parted. *J. Ag. Sp. Alg.* 2, p. 105. *Harv. Phyc. Brit.* t. 106. *Callithamnion nodulosum*, Kütz. *Sp. Alg.* p. 651. (TAB. XXXI. D.)

HAB. Key West, *W. H. H.*, 68, 69; *Dr. Blodgett*, 56, 61. (v. v.)

Fronds tufted, one to two inches long, capillary or setaceous, irregularly branched; branches lateral, alternate or secund, or sub-dichotomous, more or less divided; the lower ones moniliform, the upper more and more cylindrical from the greater closeness of the whorls of ramelli; the apices attenuated to a fine point. *Colour*, a dull, dark purple.

The Key West specimens are much infested with calcareous matter and do not recover well after having been dried. The magnified sketch in our figure was made on the spot, from fresh specimens.

Plate XXXI. C. *Fig. 1.* *CROUANIA attenuata*; a tuft, the natural size. *Fig. 2*, a branch; *fig. 3*, one of the ramelli from the same; *fig. 4*, occasionally trichotomous apices of a ramellus; the latter figures more or less highly magnified.

VI. HALURUS. Kütz.

Frond cartilaginous, filiform, articulated, monosiphonous, irregularly branched; branches clothed at the nodes with short, incurved, dichotomous, whorled ramuli. *Favellæ* generally several in a cluster, borne on the apex of a shortened branch, and sub-tended by a whorl of involucrel ramuli, containing, within a hyaline periderm, numerous angular spores. *Tetraspores* attached to the interior side of the branches of an involucre formed of dichotomous ramelli, numerous, spherical, triangularly parted.

This genus has been separated by Kützing from *Griffithsia*, with which it nearly but not exactly agrees in the fructification, and from which it differs in external habit. The plants of the present group have, except in colour, very much the appearance externally of the *Cladostephi*.

1. *HALURUS equisetifolius*, Kütz.; frond irregularly branched, the branches directed to every side; whorled ramuli incurved, forked or dichotomous, densely set, their

articulations four to eight or twelve times as long as broad. *Kütz. Sp. Alg.* p. 662. *J. Ag. Sp. Alg.* 2, p. 90. *Griffithsia equisetifolia*, Ag.—*Harv. Phyc. Brit.* t. 67. *Conferva equisetifolia*, *E. Bot.* t. 1479. *Dillw.* t. 54.

HAB. (A specimen sent to me by Mr. Hooper, of Brooklyn, without locality marked; *W. H. H.*)

Stems six or eight inches long, robust, much and very irregularly branched; the branches alternate or fascicled, undivided, but set with one or more series of lateral branches. All the parts of the frond are clothed with ramelli. On the older parts of the stem and branches these form an irregular shaggy coating; but on the younger portions they are regularly whorled at the nodes, once or twice or many times forked, imbricated, with the apices generally incurved. The articulations vary much in length in different specimens. *Colour*, when recent, a fine dark, crimson-lake. *Substance* firm. It gives out a carmine tint when plunged for a short time in fresh water. *

I regret that I cannot say from what part of the American Coast Mr. Hooper procured this plant, of which I have as yet seen but a small fragment; but it is sufficient for identification.

VII. GRIFFITHSIA. Ag.

Frond filiform, dichotomous, articulated, monosiphonous, naked. *Favellæ* generally several in a cluster, subtended by a regular involucre formed of numerous incurved ramelli, sessile or pedunculate, containing, within a gelatinous periderm, numerous angular spores. *Tetraspores* contained within an involucre formed of incurved ramelli, spherical, attached to the inner faces of the ramelli, at length tri-angulantly parted.

A large genus of rose-red or crimson, filiform, articulated Algæ of a delicately membranaceous or sub-gelatinous substance, soon decomposing in fresh water. The frond consists of a single series of large, elongated cells, with very transparent walls, forming a broad limbus to the brilliantly coloured bag of endochrome contained within. The branching is on a dichotomous model, occasionally varied by the production of lateral branches, or converted partially into a trichotomous type. The species are dispersed through the Northern and Southern Hemispheres. I can claim only the following as yet for the North American Flora.

1. *GRIFFITHSIA corallina* ? Ag.—*J. Ag. Sp. Alg.* 2, p. 78, &c. Var. β *globifera* ; filaments capillary, the lower articulations many times longer than broad, but slightly swollen ; the upper and terminal ones inflated, pyriform or globose. *Griffithsia globifera*, Harv. MS. (TAB. XXXV. A.)
 Var. γ , *tenuis* ; of small size, all the articulations slender, but slightly swollen upwards, the terminal ones attenuated.

HAB. Vars. β and γ on *Zostera*, at Greenport, Long Island, Prof. Bailey and W. H. H. Providence, Mr. Olney. New Bedford, Dr. Roche. Port Jefferson, Mr. Lounsbury. Key West, (a fragment only) W. H. H. (v. v.)

In var. β the frond is capillary or setaceous, two to three inches high, densely tufted, many times dichotomous, more or less fastigate, the upper branches sometimes, by abortion, alternate or secund ; the lower axils patent, the upper more erect. Internodes more or less swollen upwards, the lower ones many times longer than their diameter and little swollen ; the upper shorter, either pyriform or elliptical ; the terminal very frequently globose, much inflated, twice or thrice the diameter of that immediately below it. Favellæ sessile on the apex of an internode of the branches, especially of the upper ones, occupying the position of a suppressed arm of a dichotomy, subtended by a few short ramelli, one or more favellæ in each involucre. Colour rose-red, rapidly discharged in fresh water. Substance soft, gelatinoso-membranaceous, closely adhering to paper in drying.

In var. γ , the frond is one to four inches high, the lower articulations very long, some of them cylindrical, others slightly pyriform ; the upper articulations more frequently pyriform, and the terminal ones slender, the branches often tapering to a fine point. I have not seen fruit on this variety.

These two varieties appear distinct enough *on paper*, not merely from each other, but from the common European state of *Griff. corallina* ; and at first I had set aside var. β as a species, characterised by the terminal, vesicular cell. Afterwards on gathering a large number of specimens of both forms at Greenport, where they are common in August, I found some that had the peculiarities of var. β and γ combined on the same frond, and others that approached in essential characters to the ordinary *G. corallina*. None, however, that I have seen from America can be said to be absolutely similar to those from Europe, as all, however much they may put on the characters, are much more slender than any European specimens I have seen. Possibly future observations may require the establishment of a new species for these American varieties.

Plate XXXV. A. Fig. 1. *GRIFFITHSIA corallina*, var. *globifera*, the natural size. Fig. 2, a portion of the frond magnified. Fig. 3, apex with favella ; and fig. 4, spores ; highly magnified.

VIII. CALLITHAMNION. *Lyngb.*

Frond filiform, branched, articulated, monosiphonous, the stem and branches (in many species) at length rendered opaque by the development of decurrent filaments in the walls of the primary cells; ramuli always articulated, monosiphonous. *Favellæ* generally binate, axillary or sessile on the branches, naked or nearly so, containing, within a hyaline periderm, numerous angular spores. *Tetraspores* naked, sessile or pedicellate, distributed along the ramuli, oblong or globose, triangularly or cruciately parted.

A very large genus of beautiful Algæ, sometimes minute, never of large size, rarely exceeding six inches in length. The fronds in the least developed species are but slightly branched, a line or two long, parasitical, forming a down-like covering to the plants on which they grow. Others, a little more perfect, grow on rocks, on which they form dense, cushion-like tufts, from a quarter inch to an inch in height. Some few have their smaller branches and ramuli dichotomously multifid. The greater number, however, are branched on a more or less regularly pinnate type; the pinnæ and pinnulæ either opposite or alternate, rising singly or in pairs from the upper extremity of every internode. In some species every part is exactly distichous: in others the lower branches and larger divisions spread to all sides, while the lesser ones are distichous: and again, in others all the branches and their subdivisions spread in every direction. In the smaller species the whole frond is pellucidly articulate, composed of a single series of thick-walled, endochromatic cells arranged end to end; and such is the structure of the young frond in all. In the larger species, as the frond increases in age, filaments, originating in the bases of the branches, begin to be developed longitudinally in the substance of the walls of the frond. At first they are few and short, afterwards numerous and prolonged in a downward direction, and at last they completely fill the wall, rendering it opaque and concealing the articulations completely. In the strongest growing species the walls become at length very much thicker than the enclosed tube, and completely filled with such decurrent filaments.

The species are often very difficult of determination, forming numerous and most puzzling varieties. They often require very copious materials to work on before they can be well understood, and in some cases I labour under the disadvantage of having received imperfect materials. Some of the following species present so many forms, that before I had compared together very extensive suites, I was disposed to separate into four or five what I now regard as a single species. And though my friend Prof. Agardh has considerably curtailed the species as described by other writers, I fear that of the sixty-three which his work still admits, several should be struck off. To come to right conclusions on this point, the species should be studied on the sea shore, before the specimens have been dried, for the characters of many are of so delicate a nature, that they are apt to be saved or lost, according as the

specimen is well or ill dried. For the convenience of easy reference, I divide the American species into the following six sections :—

SECT. 1. FRUTICOSA : *Frond shrub-like, the stem and branches more or less filled with veins, imperfectly articulate. Ramuli pectinate or pinnate, the pinnæ alternate or secund.*

1. CALLITHAMNION *Pikeanum* ; frond robust, fruticose, with an undivided, opaque stem, set with alternate, similar branches directed to every side ; branches alternately decompound, opaque, the lesser divisions densely beset on all sides with minute, imbricated, articulated ramuli ; ramuli divaricate, pectinate or bi-pectinate on the outer side (the naked side directed to the rachis), the ultimate divisions spreading at right angles, subulate, sub-acute ; articulations of the ramuli once and half as long as broad ; tetraspores tri-partite, sessile, one or more together on the ultimate ramuli.

HAB. Golden Gate, California, *Capt. Nicholas Pike.* (v. s. in Herb. T. C. D.)

Frond solitary ? *Stem* four to five inches high, half a line in diameter at the base, undivided, slightly attenuated upwards, opaque, set with similar, opaque, alternate branches, which again bear a second or third series of similar, but smaller branches. *Branches* directed to every side, the larger ones either naked or clothed with minute, hair-like ramuli, the lesser ones very densely set on all sides with minute, multifid ramuli, one to two lines in length. These ramuli alone are pellucidly articulate, the articulations once or twice as long as broad. They are set at right angles to the branches from which they spring, but are curved or arched inwards, so as to present to the branch the concave face, which is bare of ramelli ; the convex or outward face being pectinated with horizontally patent or divaricated, spine-like, simple or again pectinellated ramelli. *Tetraspores* roundish, triangularly-parted, sessile, or borne on the ultimate divisions of the ramuli. *Favellæ* I have not seen. The *colour* is a dark, vinous purple. The *substance* is firm and rather rigid. It imperfectly adheres to paper in drying.

This species is very different from any American one known to me, but is nearly related to the European *C. Arbuscula*, and still more closely to the South African *C. purpuriferum*, J. Ag. ; but appears to be distinct from both. It is a stronger growing plant than *C. Arbuscula*, with more squarrose and thicker ramuli. From *C. purpuriferum* it differs in colour, in the ramification of the ultimate ramuli, in the much greater opacity of the stem and branches, the structure of the tetraspores, &c. I have pleasure in bestowing on it the name of Captain Nicholas Pike, of Brooklyn, an ardent student of marine plants, to whom I am indebted for a very interesting collection of Californian Algæ, among which was this species.

2. CALLITHAMNION *tetragonum*, Ag. ; frond ultra-setaceous, shrub-like, with a per-

current stem and pyramidal outline ; branches lateral, directed to every side, simple or alternately decompound, densely clothed with short, pinnato-multifid, fastigiate plumules ; ramuli divaricate, subulate ; articulations of the stem and larger branches veiny, once or twice as long as broad, of the ramuli about twice as long as broad, cylindrical or contracted at the nodes ; tetraspores very minute, tripartite, near the tips of the ramuli. *J. Ag. Sp. Alg.* 2, p. 53. *Harv. Phyc. Brit.* t. 136. *Phlebothamnion tetragonum*, Kütz. *Sp. Alg.* p. 654. *Callithamnion brachiatum*, *Harv. Phyc. Brit.* t. 137. *Conferva tetragona*, *Dillw. Conf.* t. 65. *E. Bot.* t. 1690.

HAB. Newport, Rhode Island, *Mr. Olney*, *Dr. Durkee*. Narragansett Pier, *Mr. Hunt*. Seaconnot, *Mr. C. Congdon*. Greenport, *Prof. Bailey*. (v. v.)

Fronds three to four inches high. *Colour*, a fine lake or red brown. *Substance* gelatinoso-cartilaginous.

The American specimens here described are not quite so robust as the European plant, but some of them are in other respects very similar. Others, again, show a tendency to pass into *C. Baileyi*, and almost shake my opinion of the validity of that species ; and yet its *extreme* forms are so different from the *nearest* form of *C. tetragonum*, that I dare not, as species are at present understood, unite them.

3. *CALLITHAMNION Baileyi*, Harv. ; frond setaceous, shrub-like, with a percurrent stem ; branches lateral, directed to every side, simple or alternately decompound, densely ramulose ; lesser branchlets spirally inserted, somewhat plumulate, or fasciculato-multifid, zig-zag ; ramuli alternate, subulate, incurved, acute ; articulations of the lower stem veiny, twice or thrice as long as broad, of the branches swollen at the nodes, thick-walled, without veins, three or four times as long as broad ; of the ramuli cylindrical, about thrice as long as broad ; tetraspores solitary, elliptical, on the inner faces of the ramuli ; favellæ binate. *Harv. in Bail. list of Algæ, Sill. Journ.* vol. 4, 2d. Ser., p. 38. (TAB. XXXV. B.) Var. β *boreale* ; stem pellucidly articulate, its medial articulations four or five times as long as broad, those of the branches cylindrical, and of the ramuli longer than in var. *a*. Var. γ *Rochei* ; more slender than usual and very plumose ; the ramuli elongate, patent, crowded at the ends of the branches. Var. δ *squarrosus* ; plumules short and little divided ; ramuli short, squarrose.

HAB. New Brighton, *Prof. Bailey*. Abundant in New York Bay, *Prof. Bailey*. Messrs. Hooper, Pike, &c., *W. H. H.* β , Boston Bay in various places, *Mrs. Mudge*, *Dr. Durkee*, *Miss Brewer*, &c. γ , New Bedford, *Dr. Roche*. δ , Red Hook, *Mr. Hooper*. (v. v.)

Fronds tufted or solitary, shrub-like. *Stems* as thick as hog's bristle, two to three inches long, generally undivided and closely beset on all sides with similar, undivided, long lateral branches, the lowest of which are longest, the rest successively shorter, so that the outline of the frond is pyramidal. In luxuriant specimens

these primary branches bear a second or third series of similar lesser branches. *Branches* densely set with short, spirally inserted branchlets, the lowest of which are simple or bifid, the upper more compound or somewhat plumulate; the *plumule* either pinnate or bi-pinnate, the upper pinnules being frequently pinnellate. *Ramuli* subulate, mostly incurved, tapering to a fine point. *Articulations* variable in length; those of the main stem generally veiny, sub-opaque; those of the branches destitute of veins except in very old specimens, swollen at the nodes, with narrow endochrome and thick, hyaline walls; those of the ramuli from three to four or five times as long as broad. *Tetraspores* mostly solitary, near the middle of the ramuli. *Favellæ* in pairs on shortened plumules. *Colour*, a fine, dark red. *Substance* rather soft. It closely adheres to paper in drying.

The original specimens received from Prof. Bailey appeared, when I first examined them, to constitute a well marked species, readily distinguishable from all others; and specimens sent to me from various correspondents, and others collected by myself at New York, agree with them in all essential characters. But many other specimens have also reached me which vary greatly from the type, especially in the length of the articulations, and yet which are too closely connected with the first specimens to warrant their specific separation. In our var. β *boreale*, which is the common form of the species in Massachusetts Bay, the frond is more pellucid, of a brighter colour, with longer internodes. But the most delicately beautiful feathery specimens are those received from Dr. Roche of New Bedford, which are so unlike the New York plant, that but for the Boston variety just mentioned, I should hardly have ventured to unite them. Again, the most robust forms, with shortest joints, approach *inconveniently* near to *C. tetragonum*, from which species the more delicate ones appear widely different. Future observations may perhaps show that Dr. Roche's specimens should be separated; but if this be done, what I now regard as a single species must be split into four or five.

Plate XXXV. B. *Fig. 1.* CALLITHAMNION *Baileyi*; the natural size. *Fig. 2,* plumule and part of lesser branch of the var. β *boreale*; *fig. 3,* favellæ from the same; *fig. 4,* part of stem of the normal variety (α); *figs. 5 and 7,* plumules from the same; *fig. 6,* a ramulus, with tetraspores; the latter figures more or less magnified.

SECT. 2 ROSEA: *Fronds capillary or byssoid, densely tufted, articulated throughout, (the older parts of the stem veiny, but not opaque) decompound-pinnate; pinnæ and pinnules alternate.*

4. CALLITHAMNION *squarrulosum*; frond setaceous, distichous; stem and larger branches veiny toward the base, but visibly articulate throughout, percurrent, set with lateral, flexuous, alternate branches, which are naked or with a few squarrose ramuli below and alternately decompound beyond the middle; secondary branches of unequal lengths, very patent, laxly set with alternate, simple, bifid or pinnulate divaricating, obtuse ramuli; articulations four or five times as long as broad, the cell-walls thick and endochrome narrow.

HAB. Golden Gate, California, *Capt. N. Pike.* (v. s. in Herb. T. C. D.)

Frond two to three inches high, as thick as hog's bristle below, tapering to a capillary diameter above. *Stem* percurrent, slightly flexuous, set with alternate, distichous, sub-horizontal branches, the lowest of which are longest. General outline of the frond ovate. *Branches* flexuous, naked in the lower half or with a few squarrose ramuli, alternately branched beyond the middle; the secondary branches of very unequal lengths, ziz-zag, simple or variously decompose, sometimes resolved into an intricate, thorny, bushy head. *Ramuli* all very patent, alternate, variously compound, some quite simple, some bifid or trifid, and some pinnulate, the pinnelli divaricating. *Stem* veiny below, but not opaque. *Articulations* of nearly uniform length in all parts of the frond, except toward the base of the stem. *Cell walls* remarkably thick. No fruit seen.

Of this apparently distinct species I have seen but a single specimen, and probably the specific character and description may require to be revised and corrected. Had the specimen come from the Atlantic Coast I should hardly have ventured to propose a species on such imperfect materials.

5. *CALLITHAMNION Borreri*, Ag.; fronds densely tufted, capillary, pellucidly articulate to the base, pinnately or flabellately branched; branches beset in their lower part with spirally inserted, mostly simple, elongate ramuli, distichously plumulate above; plumules fan-shaped, bare of ramuli in the lower half, simply pinnate beyond the middle; the pinnæ patent or incurved, not much tapered, obtuse; articulations of the branches two to six times, of the pinnæ twice or thrice as long as broad; tetraspores numerous on the inner face of the pinnæ. *J. Ag. Sp. Alg.* 2, p. 49. *Harv. Phyc. Brit.* t. 159. *Kütz. Sp. Alg.* p. 643. *Conferva Borreri*, *E. Bot.* t. 1741.

HAB. New Bedford, *Dr. Roche.* Newport and Newhaven, *Dr. Durkee.* Seannot, *Mr. Congdon.* New York, *Messrs. Walters, Hooper, Calverley, &c.* (v. v.)

Tufts one to three inches high, dense, sub-fastigiate. *Filaments* decompose from the base, the lower branches spreading to all sides, often of nearly equal length; the lesser branches irregularly inserted, either naked in their lower half, or beset with long, simple, hair-like ramuli, distichously plumulate beyond the middle. The *plumules* are petiolate, or naked below, pinnate above. Pinnæ spreading, obtuse. *Articulations* throughout the plant (except rarely near the base of the stem) destitute of veins; those of the stem very variable in length in different specimens, sometimes only twice or thrice, sometimes four to six times as long as broad; those of the ramuli more uniform, and mostly contracted at the nodes. *Tetraspores* on the inner face of the ramuli, sometimes few, sometimes many.

More slender and softer than the common European form; and had my attention been confined to Mr. Congdon's specimens I should possibly have described them as a

distinct species. But Dr. Roche's specimens above noticed seem to connect Mr. Congdon's with some European varieties of this variable species.

At Greenport, Long Island, I collected a *Callithamnion*, infested by parasites and otherwise in bad order, which at present I doubtfully refer to *C. Borreri*. These specimens are more robust than the other North American ones, but not more so than European states of the species, and despite some minor peculiarities I hesitate to pronounce them different. Possibly more perfect specimens would compel us to separate them.

6. *CALLITHAMNION polyspermum*, Ag.; fronds densely tufted, capillary, much branched, pellucidly articulate nearly to the base, decompound pinnate; main branches either naked or ramulose below, distichously plumulate above; plumules linear or oblong in outline, simply pinnate; pinnæ incurved, obtuse, cylindrical, nearly equal in length, the uppermost sometimes pinnulate near the tips; articulations of the stem mostly veinless, three or four times, of the pinnæ twice or thrice as long as broad; tetraspores elliptical, solitary, or two or more together near the base of the pinnæ. *J. Ag. Sp. Alg.* 2, p. 48. *Harv. Phyc. Brit.* t. 231. *Phlebothamnion polyspermum*, Kütz. *Sp. Alg.* p. 653.

HAB. Hellgate, New York, *Mr. J. Hooper*. Jackson Ferry, *Messrs. Walters and Pike*. Sullivan's Island, Charleston, *Prof. L. W. Gibbes* and *W. H. H.* St. Augustine, Florida, *Prof. J. W. Bailey*. (v. v.)

Tufts two to three inches high. Filaments capillary, irregularly branched from the base, the main branches frequently naked below and distantly divided, their divisions decompound-pinnate or closely plumulate in the upper half. Plumules distichous, broadly oblong or linear, rounded at the top, scarcely petiolate, the lowest pinnæ generally springing from the second articulation counting from the base of the rachis; pinnæ simple, linear and obtuse, the upper ones not remarkably shorter than the lower. Tetraspores frequently solitary on the second or third joint from the base, elliptical, sometimes two or three or more on the same pinnule. Favellæ, near the ends of shortened plumules, in pairs. Colour, a fine purplish-red, given out in fresh water. Substance, soft, but not gelatinous. It closely adheres to paper in drying.

A variable species, allied on the one hand to *C. Borreri*, and on the other to *C. roseum*. The above description is taken exclusively from American specimens, which, though not strictly agreeing with the typical state, figured in *Phyc. Brit.*, are very similar to many specimens from the South of England; particularly to those from Plymouth Harbour.

7. *CALLITHAMNION byssoideum*, Arn.; fronds densely tufted, of extreme tenuity, very flaccid and tender, pellucidly articulate nearly to the base, excessively

branched ; lower branches irregularly divided, the upper decompound-pinnate and plumulate ; plumules flexuous, distantly and rather irregularly pinnate, the pinnæ alternate or secund, slightly tapering, obtuse, often ramulose toward the point ; articulations of the branches six or eight times, of the ramuli three to six times as long as broad ; tetraspores elliptical, tripartite, secund, several on each pinna ; favellæ binate. *J. Ag. Sp. Alg.* 2, p. 40. *Harv. Phyc. Brit. t.* 262. *Phlebothamnion byssoides*, Kütz. *Sp. Alg.* p. 657. *Callith. arachnoideum*, *Ag. Sp. Alg.* p. 181. Var. β *unilaterale* ; of smaller size and still greater tenuity than the ordinary form ; the branches and ramuli very frequently secund, the plumules irregular, sometimes alternately pinnate, sometimes secondly pectinate. *Cal. unilaterale*, *Harv. MSS.* (not of Zanard.) Var. γ *fastigiatum* ; branches fastigate, the lesser ones densely ramulose at the tips. Var. δ *Waltersii* ; more rigid than usual, the upper branches distichously decompound-pinnate, ramuli remarkably patent.

HAB. New York Harbour, in several places from Hellgate to Port Hamilton, Messrs. Hooper, Walters, Congdon, Calverley, &c. Var. β , Massachusetts Bay, Mrs. Mudge, Dr. Durkee, Miss Mitchell, Capt. Pike, &c. Greenport, Prof. Bailey, W. H. H. &c. (v. v.)

Tufts large and dense, one to three inches high. *Filaments* much finer than human hair, excessively flaccid, soft and sub-gelatinous, collapsing into a clot when removed from the water, much branched ; the lower branches very irregular, sometimes close together and dividing at short intervals, sometimes more distantly branched ; the upper branches repeatedly decompound-pinnate. *Plumules* sometimes long and virgate, narrow, simply pinnate or having the upper pinnules pinnellate or secondly ramulose ; sometimes shorter and more ovate, and frequently with a flexuous rachis. *Articulations* destitute of veins, except near the base of the stem, many times longer than broad in the larger branches, four or five times or more in the smaller, cylindrical. *Tetraspores* on the inner face of the pinnulæ, few or several, secund, elliptical. *Favellæ* not seen on American specimens. *Colour*, a fine purplish rose-red. *Substance* very tender.

Var. β is smaller and still more slender than the common form, with longer internodes, and its typical state is readily known by the strong tendency to secund ramification ; but this character is very variable.

In some of the numerous and beautifully preserved specimens with which Mr. Walters has favoured me, the ends of the upper branches are remarkably fastigate and densely ramulose, and the external aspect is strikingly similar to that of *C. corymbosum*. Another specimen from the same gentlemen, dated July 6, 1851, has, to the naked eye, the aspect of *C. gracillimum*, the upper branches being distichously decompound-pinnate, with an ovate outline ; all the ramuli remarkably patent and even recurved, the ultimate ones very generally secund. The substance appears rather more rigid than usual ; and had I received this specimen alone it might possibly have passed for a distinct species ; but after comparison with a large number of North American specimens of *C. byssoides*, I fear its distinctive

characters are not sufficiently marked. Meantime I indicate it above as var. *δ Waltersii*.

8. *CALLITHAMNION Dietziæ*, Hooper ; fronds capillary, pellucidly articulate nearly to the base, the lower part of the percurrent, distichously-pinnate stem veiny ; branches alternate, simple, set at each node with short, alternate, sub-simple or pinnato-dichotomous plumules, and often terminated by a dense fascicle of ramuli ; rachides zig-zag ; articulations of the stem six or eight times, of the rachides three or four times, of the ramuli eight or ten times as long as broad ; apices sub-attenuate, obtuse, or sub-acute ; tetraspores elliptical, tripartite, solitary on the uppermost ramuli.

HAB. Greenport, *Mrs. Dietz*. (v. s. in Herb. Hooper.)

Fronds tufted, two to three inches long, as thick as human hair. *Stem* either simple or divided near the base into several, long, simple, erect, main divisions, set throughout with alternate, patent, elongate, simple branches, which, in luxuriant specimens, probably bear a second set of similar smaller ones. Outline of the frond ovato-lanceolate. *Branches* alternate or sometimes secund, sub-distichous, articulate, each node bearing at alternate sides of the branch, a pinnato-dichotomous branchlet or plumule. *Plumules* with a zig-zag rachis, either short with three or four pinnae, or lengthening out, simply pinnate in the lower half, bi-pinnato-dichotomous above, each pinnule ending in a dense tuft of undeveloped ramuli. *Articulations* of the lower part of the stem three or four times as long as broad, veiny, with a narrow tube ; of the branches with thick, pellucid walls, six or eight times ; of the rachides of the plumules shorter, but of the ultimate pinnules six to eight or ten times as long as broad. *Colour*, a beautiful rosy-red. *Substance* soft, closely adhering to paper. *Tetraspores* tripartite, elliptical, solitary on the ultimate ramuli, formed from the suppressed arm of a furcellation.

Of this plant I have yet seen but few specimens ; too few to form a decided opinion on its specific validity. Notwithstanding its pinnate habit I am not without fears that a more extensive suite of specimens may show it to pass off into one of the forms of *C. corymbosum* or *C. versicolor*. The specific name is bestowed by Mr. Hooper in honour of its discoverer, *Mrs. Dietz* of New York.

SECT. 3. CORYMBOSA ; *Fronds setaceous or byssoid, alternately decompound ; the secondary branches and ramuli dichotomous, corymboso-fastigiate.*

9. *CALLITHAMNION corymbosum*, Ag. ; fronds tufted or solitary, flabelliform, pellucidly articulate throughout ; stem and lower branches setaceous below, attenuated upwards to a byssoid fineness, decompound, much branched ; upper branches byssoid, excessively flaccid, pinnato-dichotomous or alternately or secundly decomp-

pound ; the lesser and ultimate divisions dichotomously multifid and fastigate ; articulations of the branches six or eight times as long as broad, of the ramuli shorter ; tetraspores solitary on the ramuli, tripartite. *J. Ag. Sp. Alg.* 2, p. 41. *Harv. Phyc. Brit.* t. 272. *Phlebothamnion corymbosum*, Kütz. *Sp. Alg.* p. 657. *Conferva corymbosa*, *E. Bot.* t. 2352. Var. β *secundatum* ; lesser branches very frequently secund, less compound than usual, and the ultimate ramuli very irregular, scarcely corymbose.

HAB. Frequently growing on *Zostera*. Halifax, *W. H. H.* Boston Bay in several places, *Dr. Durkee*, *Mrs. Mudge*, *Capt. Pike*, &c. New London, *Miss French*, *Mr. Congdon*. Providence, *Prof. J. W. Bailey*. β , Massachusetts Bay, *Mrs. Mudge*. Greenport, *Mr. Hooper*. (v. v.)

Fronds either densely tufted, as is often the case when growing on the leaves of *Zostera*, or solitary, as sometimes occurs in rockpools or on a sandy bottom. *Stems* as thick as hog's bristle at the base, soon divided, and then alternately decompound. The larger branches are setaceous below, attenuated upwards, and at length reduced, near the summit, to a cobwebby fineness ; they are very much branched, the primary divisions between alternately pinnate and dichotomous, the secondary and tertiary somewhat zig-zag and set with alternate or secund, dichotomo-multifid branchlets. These dichotomous branchlets are usually fastigate or level-topped ; the ends, owing to the crowded ramuli, looking dark when displayed on paper, and resembling so many little corymbs ; whence the specific name. The articulations are visible to the base of the stem ; those in the lower part are short, sometimes a little veiny, thick-walled, with a slender tube ; those of the middle and upper portions are very long. The *tetraspores* are always solitary, scattered on the upper ramuli, being formed out of a suppressed arm of a furcellation. *Favellæ*, binate. *Substance*, somewhat gelatinous. *Colour*, a beautiful rosy red, rapidly given out in fresh water.

10. *CALLITHAMNION seirospermum*, Griff. ; fronds solitary or somewhat tufted ; stem setaceous, veiny, gradually attenuated upwards, undivided, set with alternate, lateral, setaceo-capillary, veiny, undivided branches, which are clothed with lateral, spirally inserted, dichotomo-multifid, secondary branchlets ; articulations of the stem and branches opaque, of the lesser branches and ramuli pellucid, three to four times as long as broad ; the ultimate ramuli frequently converted into bead-like strings of seirospheres. *Harv. Man. Ed.* 1, p. 113. *J. Ag. Sp. Alg.* 2, p. 42. *Phlebothamnion seirospermum*, Kütz. *Sp. Alg.* 2, p. 657. *Seirospora Griffithsiana*, *Harv. Phyc. Brit.* t. 21. *Cal. versicolor*, var. *seirospermum*, *Harv. in Hook. Joam, Bot.* 1, p. 302.

HAB. Salem, Massachusetts, *Mr. J. Hooper*. New Bedford, *Dr. Roche*. Nantucket, *Dr. Durkee*. Shores of Rhode Island, *Prof. J. W. Bailey*. (v. v.)

Stem, three to five inches high, as thick as hog's bristle below, capillary above,

undivided, running through the frond, set throughout with alternate, spirally-inserted, lateral, sub-horizontal branches directed to all sides, the lowest longest, the rest successively shorter; the whole frond pyramidal. Both the stem and primary branches are filled with veins, which render their articulations more or less obscure. *Branches* undivided, one to two inches long, attenuated upwards, and copiously furnished throughout with short, very flaccid, capillary or byssoid, dichotomo-multifid branchlets directed to every side; the ultimate divisions of these are almost cobwebby. I have not seen proper *tetraspores*; but their place is generally supplied by the conversion of the ultimate ramuli into strings of spores; affording a mark by which this species is most easily recognised. When first I described this fructification (in *Hook. Journ. l. c.*) I regarded it as an abnormal development, and perhaps correctly, though more recently (in the *Phycologia Britannica*) I adopted another opinion, and thereon founded the genus *Seiropora*. If the strings of *seiospores* be abnormal, however, they are, so far as I know, only found in this species, and are very constant, characterising it on the shores of England, Ireland, Scotland and Sweden, as well as on those of North America. I am indebted to Dr. Roche of New Bedford for most beautiful specimens, which are identical with the most luxuriant of my English ones.

SECT. 4. CRUCIATA: *Fronds setaceous or capillary, alternately decompound, articulate; each node bearing a pair of opposite, minute, simple or compound ramuli. Tetraspores cruciate.*

11. *CALLITHAMNION plumula*, Lyngb.; stems alternately decompound or sub-dichotomous, articulated; each articulation bearing a pair of short, recurved, pectinate or bi-pectinate ramuli; tetraspores borne on the tips of shortened ramuli, cruciate. *J. Ag. Sp. Alg.* 2, p. 29. *Harv. Phyc. Brit.* t. 242. *Kütz. Sp. Alg.* 2, p. 647. *Conferva Plumula*, Ellis.—*Dillw.* t. 50. *Conf. Turneri*, E. Bot. t. 1637.

HAB. Longbranch, New Jersey, Miss E. C. Morris. (v. v.)

Of this beautiful species I have only seen a solitary, ill-dried and faded North American specimen. It is at once known from *C. Americanum*, which is sometimes mistaken for it by collectors, by the very patent or recurved ramuli, closely *pectinated* on their upper margin only, with secund pinnellæ.

12. *CALLITHAMNION Americanum*; filaments elongate, capillary, many times alternately decompound, closely and densely or sub-distantly branched, plumose; ramuli in pairs from every node, opposite, patent, very slender, pinnellate or bi-pinnellate, the pinnules opposite or secund; lower articulations of the stem eight or ten times, upper four or five times as long as broad; articulations of the ramuli four to six times as long as broad; tetraspores elliptical, cruciate, sessile; favellæ in pairs on the upper branches. (TAB. XXXVI. A.)

HAB. Prince Edward's Island, *Dr. Jeans*. Halifax, *W. H. H.* Boston, *Mrs. Asa Gray*. Lynn, *Mrs. Mudge*. Portsmouth, *Dr. Durkee*. New Bedford, *Dr. Roche*. New York Bay, *Mr. Hooper*. (v. v.)

Filaments three to four inches long, capillary, densely tufted, much and finely branched, alternately decomposed; the lower divisions sub-distant, the upper close together, all rather patent, the secondary branches elongate, the tertiary and succeeding short. Every part of the filament is pellucidly articulate, without veins. Each articulation bears a pair of very slender, byssoid, opposite ramuli one to two lines long, very patent and oppositely pinnate or bi-pinnate; the pinnules sometimes abortive or abbreviated, when the branching becomes irregularly alternate or sub-secund. *Apices* attenuate, acute. *Articulations* in the lower part of the stem and branches many times longer than broad, in the lesser branches five or six times, in the ramuli frequently six or eight times, but sometimes only four or five times as long as broad. *Tetraspores* sessile, near the base of the pinnæ on the ramuli, elliptical, cruciate. *Favellæ* near the ends of the lesser branches, large, berry-like, in pairs or threes. *Colour*, a brilliant, rosy red. *Substance*, very flaccid and delicate. It closely adheres to paper in drying.

A very beautiful species, not uncommon on the East Coast of North America from Nova Scotia to New York.

Plate XXXVI. A. *Fig. 1.* *CALLITHAMNION Americanum*; the natural size. *Fig. 2,* part of a larger branch, with lateral branches, and pinnate, opposite ramuli; *fig. 3,* part of a branch with *favellæ*; *fig. 4,* the same with *tetraspores*; *fig. 5,* a fertile, lower pinna from the preceding; the latter figures more or less highly magnified.

13. *CALLITHAMNION Pylaisæi*, Mont.; filaments elongate, ultra-capillary, alternately decomposed; branches distant, erecto-patent; ramuli in pairs, opposite at every node, pinnate or bi-pinnate, the pinnæ opposite or rarely secund; lower articulations of the stem many times longer than broad, upper two to four times; articulations of the ramuli once or twice as long as broad; tetraspores elliptical, sessile on the ramuli, cruciate. *Mont. Ann. des Sc. Nat. 2nd Ser. vol. viii. p. 351.* *Wragelia Pylaisæi*, *J. Ag. Sp. Alg. 2, p. 705.* *Callith. intermedium*, *Harv. MSS.* (TAB. XXXVI. B.)

HAB. Newfoundland, *De la Pylaie*! South Boston, *Dr. Durkee*! (v. s. in Herb. T. C. D.)

Filaments three to four inches, rather thicker than human hair, alternately four or five times decomposed, the lower branches distant, the upper gradually nearer; every part pellucidly articulate. From a short distance below each node of the stem and branches springs a pair of opposite ramuli about half a line in length, some of them simply pinnate, some few secundly pectinate, but the greater number bi-pinnate, ovate in outline, all the pinnules tapering to an acute point. Lower

articulations of the stem six to eight or ten times as long as broad ; upper much shorter, and those near the ends of the branches but twice or thrice as long as broad. The articulations of the ramuli are very short. *Tetraspores* numerous on the pinnæ of the ramuli, sessile, cruciate. *Favellæ* unknown. *Colour* a fine crimson.

This plant has the external aspect of *Cal. floccosum*, but is more robust, and is readily distinguished by its compound ramuli. It is more closely related to *C. Americanum*, but the ramuli are shorter and more densely branched, with much shorter internodes. The differences between these species may more readily be understood, by comparing the figures we have given than by a detailed description.

Until the favellæ of this plant be discovered, some doubt may rest upon its generic position, yet I cannot but think it more nearly related to *C. Americanum* and *C. floccosum*, between which it is nearly intermediate in character, than to *Wrange-lia multifida*, with which Professor Agardh associates it.

Plate XXXVI. B. *Fig. 1.* *CALLITHAMNION Pylaisæi* ; the *natural* size. *Fig. 2.* portion of a branching stem, *magnified*. *Fig. 3.* internode of a branch, with opposite, bi-pinnate, fertile ramuli ; *fig. 4.* pinnule from the same, with *tetraspores* ; more highly *magnified*.

14. *CALLITHAMNION floccosum*, Ag. ; frond capillary, very flaccid, remotely much branched ; branches alternate, erecto-patent, articulated ; every node emitting a pair of opposite, simple, subulate, erecto-patent, minute, ramuli ; tetraspores elliptical, pedicellate on the ramuli near the base. *J. Ag. Sp. Alg.* 2, p. 27. *Harv. Phyc. Brit.* t. 81. *Kütz. Sp. Alg.* p. 646.

HAB. South Boston, very rare, *Dr. Durkee*. (v. s. in Herb. T. C. D.)

Filaments capillary, four to six inches long, alternately or sub-dichotomously branched, the lower divisions distant, from half an inch to an inch or more apart, the upper gradually closer together. Secondary and lateral branches repeatedly divided alternately ; the general outline lanceolate or somewhat rhomboid. *Ramuli* opposite, a pair springing from every internode of the frond at a short distance below the node, distichous, a quarter to half a line long, erecto-patent, quite simple spine-like, subulate, tapering to an acute point. *Articulations* in the lower part of the stem six or eight times as long as broad, without veins ; in the upper branches gradually shorter, near the apices twice or thrice as long as broad, the terminal ones shorter than their breadth. *Articulations* of the ramuli once and half or twice as long as broad.

I have as yet seen but a solitary American specimen, and it is without fruit.

15. *CALLITHAMNION cruciatum*, Ag. ; filaments short, in globular tufts, sub-fastigiate, alternately decompound ; branches erect ; ramuli at every node in pairs

or fours, densely crowded at the tips of the branches, opposite, very erect, pinnate ; pinnæ opposite, very erect, cylindrical, obtuse, scarcely tapering ; articulations of the stem and branches variable, of the ramuli three or four times as long as broad ; tetraspores terminating the lower, abbreviated pinnæ of the ramuli, cruciate. *J. Ag. Sp. Alg.* 2, p. 27. *Harv. Phyc. Brit.* t. 164. *Kütz. Sp. Ag.* p. 549. β *tenue* ; slender, with more distant, less compound and shorter ramuli.

HAB. New York Bay, at Red Hook, *Messrs. Walters and Hooper.* (v. v.)

Tufts dense, globose and somewhat level-topped, an inch to an inch and half high. *Filaments* capillary, alternately divided, but not much branched, the branches erectopatent, the upper ones shorter and closer together, the lower distant. *Ramuli* at every node two opposite or four in a whorl, half a line to a line in length, densely crowded at the ends of the branches, rarely more than simply pinnated. *Pinnæ* very erect, opposite or, by suppression of one, alternate or secund, the inner pinnæ being most commonly abortive, cylindrical, or slightly tapering to an obtuse point. *Internodes* of the stem and branches four to six times as long as broad, of the upper branches twice or thrice, of the ramuli about thrice as long as broad. *Fruit* rare and not yet observed on American specimens. *Colour*, a brownish-red, inclining sometimes to purple. *Substance* soft, but not very flaccid. It adheres closely to paper in drying.

As yet I am only aware of the single American station for this species above given. Mr. Walters's specimens of both varieties are very similar to those found in the South of England.

SECT. 5. REPENTIA. *Fronds* (of small size) rising from prostrate creeping matted threads. *Favellæ* involucrate.

16. CALLITHAMNION *Turneri*, Ag. ; filaments (densely tufted) rising from prostrate, creeping fibres, simple or repeatedly branched, once or twice pinnated with opposite or alternate spreading, simple ramuli ; articulations very variable in length, 5—10 times as long as broad ; tetraspores clustered, sub-racemose or corymbose, on abbreviated ramuli ; favellæ involucrate. *J. Ag. Sp. Alg.* 2, p. 23. *Harv. Phyc. Brit.* t. 179. *Kütz. Sp. Alg.* p. 649. *Conferva Turneri*, *Dillw.* t. 100, *E. Bot.* t. 2339. β *variabile* ; branches and ramuli alternate or secund. *Callithamnion variabile*, *Ag. Cal. roseolum* ? *J. Ag. Sp. Alg.* 2, p. 21. *Conferva repens*, *Dillw.* 18, *E. Bot.* t. 1608.

HAB. Parasitical on various Algæ. Rhode Island, on *Cladostephus*, *Prof. J. W. Bailey.* β Boston, *Dr. Durkee.* Key West, *W. H. H.* (v. v.)

Filaments rising from decumbent, creeping, matted fibres, densely tufted, half an inch to an inch in height, capillary, flaccid, sub-simple, or once or twice oppositely branched ; stem, branches and ramuli all nearly of the same diameter, and all pellu-

cidly articulate, with thick hyaline cell-walls. *Articulations* very variable in length in different specimens and in different parts of the same specimen, four to twelve times as long as broad, the upper ones shortest. *Branches* and ramuli patent, scarcely attenuate, obtuse, in some specimens regularly opposite, in others frequently alternate or secund. *Tetraspores* almost always pedicellate (terminating depauperated ramuli), solitary or clustered, spherical, tripartite, with broad perispores. *Colour*, a rosy or brownish red. *Substance* soft. It adheres to paper.

Our var. β closely agrees with specimens of *Cal. roseolum*, Ag. communicated to me by Prof. Areschoug; but I think it also passes insensibly into the *Cal. variabile*, Ag. which Prof. J. Agardh now agrees with me in uniting to *C. Turneri*. In Prof. Bailey's specimens the ramuli are almost always opposite; in Dr. Durkee's as constantly alternate or secund; each agrees with a corresponding British form of this variable species.

SECT. 6. PUSILLA : *Root a small callus. Fronds, minute, tufted, irregularly decom-pound, erect, growing on rocks, or parasitical.*

17. CALLITHAMNION *Rothii*, Lyngb.; tufts widely spreading, dense, velvety; filaments very slender, short, erect, dichotomous or irregularly branched; branches long, straight, very erect or appressed; articulations about twice as long as broad; tetraspores clustered, borne on short, sub-terminal, corymbose ramuli. *J. Ag. Sp. Alg.* 2, p. 17. *Kütz. Sp. Alg.* p. 640 *Harv. Phyc. Brit.* t. 120. *B. Conferva Rothii*, *Dillw. Conf.* t. 73, *E. Bot.* t. 1702. *Byssus purpurea*, *E. Bot.* t. 192. *Dillw. Conf.* t. 43.

HAB. On submarine rocks near high water-mark. Halifax, W. H. H. Penobscot Bay, Mr. Hooper. Rhode Island, Prof. Bailey. (v. v.)

Filaments about a quarter inch in height, spreading in a continuous, velvety pile, resembling crimson plush, over rocks and stones in patches from a few inches to many feet in extent. The plant is more or less luxuriant as it grows in deep or shallow water. The depauperated state called *Byssus purpurea*, E. Bot. grows at the extreme limit of the tide, in places where it is merely wet by the spray at high water.

The American specimens are not in fruit, but in other respects are the same as British ones.

18. CALLITHAMNION *luxurians*, J. Ag.; filaments minute (2—3 lines high), excessively branched from the base, sub-dichotomo-multifid or secundly decom-pound; branches rather patent, very long, attenuated, with secund, whip-like, secondary branches and few ramuli; articulations four times as long as broad; tetraspores elliptical, pedicellate, scattered. *J. Ag. Sp. Alg.* 2, p. 14. *Kütz. Sp. Alg.* p. 639.

HAB. On *Zostera* at Newhaven, Connecticut, *Mr. Hooper*. (v. s. in Herb. Hooper).

Filaments forming a dense, deep-purple fringe, two or three lines in length, to the leaves of *Zostera*, excessively branched in a manner between alternate and dichotomous, the lesser divisions very generally secund. *Branches* flexuous, flabelliform.

The American specimens seen are faded. In other respects they agree with an authentic specimen received from Prof. J. Agardh; but I must add that this species appears to me to border too closely on the following, which is of earlier date.

19. *CALLITHAMNION virgatulum*, Harv.; filaments minute (2—3 lines high), flabellately much branched from the base; branches alternately decompound, fastigate; secondary ones few, erect, straight, rod-like, frequently secund; ramuli short, secund, often rising from every node; articulations about three times as long as broad; tetraspores elliptical, pedicellate, scattered on the branches. *Harv. in Hook. Br. Fl.* 2, p. 349. *Harv. Phyc. Brit. t.* 313.

HAB. Parasitical on *Dasya elegans*, at Hellgate, New York, *Mr. Walters*. (v. v.)

*Fronde*s forming a dense velvety pile, nearly of the same colour as the byssoid ramelli of the *Dasya*, and therefore likely to be overlooked. *Filaments* alternately or secundly decompound, all the angles acute and branches and their divisions straight and erect. *Ramuli* bud-like, secund, along the branches.

20. *CALLITHAMNION Daviesii*, Ag.; filaments minute (2—3 lines high), tufted, much branched; branches curved, scattered, patent; ramuli elongate, fascicled or crowded toward the axil of the secondary branches; tetraspores pedicellate, on sub-axillary ramuli. *J. Ag. Sp. Alg.* 2, p. 11. *Harv. Phyc. Brit. t.* 314. *Kütz. Sp. Alg.* p. 638. *Conferva Daviesii*, *E. Bot. t.* 2329.

HAB. Parasitical on *Ceramium rubrum*. Boston Bay, *Miss E. Brewer*, *Dr. Durkee*. (v. v.)

Filaments about a line in height, generally forming a fleecy down on the *Ceramium*, more or less branched; sometimes sub-simple. *Colour*, a pinky-red.

APPENDIX.

GENERA INCERTÆ SEDIS.

[The following genera cannot be satisfactorily referred to their proper places in the system until their fruit shall have been discovered. *Wurdemannia* may perhaps belong to *Gelidiaceæ*; and *Pikea*, either to *Sphærococcoideæ* or to *Ceramiaceæ*.]

WURDEMANNIA. (*Nov. Gen.*)

*Fron*d filiform, terete, irregularly branched, composed of three strata; the medullary of numerous, slender, cylindrical, seriated cells, disposed in sub-parallel, closely packed, longitudinal filaments; the intermediate of oblong, longitudinal cells gradually shorter towards the periphery, which consists of minute, vertical cellules, in a nearly single row. *Conceptacles* (unknown.) *Tetraspores* oblong, zonate, immersed in the peripheric cells of the swollen apices of the branches.

The little plant on which I venture to found the present genus has puzzled me a good deal. In its aspect it resembles *Caulacanthus*, but has a structure more nearly agreeing with that of *Gelidium* than of any other genus with which I have compared it. From *Gelidium*, however, it differs essentially in the zonate tetraspores. I had at one time thought of placing it, provisionally, in *Dicranema*, but after having consulted with my friend Prof. Agardh, who is equally unable with myself to point out its true affinities, I have determined to propose it as the type of a new genus, though its claims cannot be fully substantiated until the conceptacles shall be discovered. Meanwhile I inscribe it with the name of the late DR. WURDEMAN, a most meritorious naturalist, who first explored the marine botany of the Florida Keys, and from whom (through Prof. Lewis R. Gibbes) I received specimens of this plant, among many others.

Owing to the tenuity of the frond, it is difficult to obtain a longitudinal section. The structure above described has been ascertained by viewing small portions which had been treated with muriatic acid, and then strongly pressed between pieces of glass.

1. *WURDEMANNIA setacea* ; frond capillary, densely tufted, slightly branched, sub-dichotomous ; branches simple, naked, divaricating, the apices obtuse ; tetraspores zonate, lodged in the incrassated, club-shaped apices, or in club-shaped, apical, clustered ramuli.

HAB. Key West, abundant, *Dr. Wurdeman, W. H. H. (53.)* (v. v).

Fronde densely tufted, covering other Algæ, corals and Gorgoniæ with a shaggy coat, 2—3 inches high, as thick as horse-hair, rigid, matted together, not much branched. *Branches* irregularly dichotomous or secund, widely spreading and divaricate, equal in diameter throughout, their lesser divisions few, and similar in every respect. *Ramuli* very few, a line long, and mostly towards the ends of the branches. *Tetraspores* zonate, crowded in the apical, club-shaped, somewhat flattened and frequently fasciculate ramuli. *Colour*, a dark red. *Substance*, rather rigid. It scarcely adheres to paper in drying.

PIKEA. (*Nov. Gen.*)

Frond plano-compressed, linear, cartilaginous, internally costate, distichously decomposed, composed of three strata : the *axis* being a single, articulated, per-current filament ; the *intermediate stratum* consisting of slender, longitudinal, densely packed, anastomosing filaments ; the *cortical* very narrow, formed of minute cells. *Fructification* unknown.

In the absence of all knowledge of the fructification of this curious plant, it is impossible to speak with certainty of its affinities. Notwithstanding its inarticulate frond, I am disposed to refer it to *Ceramiaceæ*, near *Carpoblepharis* ; but this opinion is grounded as much on external habit as on the internal structure. Mere outward form, however, is a most fallacious guide to natural affinities ; and there are certain *Sphærococcoideæ* and *Cryptonemiaceæ* (especially *Prionitis*), to which, outwardly, our plant has considerable likeness. I am not acquainted with any Alga exactly agreeing in structure with it, and therefore propose it as the type of a new genus, which I inscribe to CAPT. NICHOLAS PIKE of Brooklyn, from whom I received the specimens, and whose many contributions of materials to the present volume are recorded under the species received from him.

1. *PIKEA Californica* ; frond linear, more or less strongly compressed, flabelliform, distichous, sub-fastigiate ; branches irregularly disposed, repeatedly com-

pound, irregularly pinnate or secundly ramulose, the divisions erecto-patent, sometimes opposite, frequently secund, the upper ones plano-compressed; ultimate ramuli filiform or subulate, acute, not tapering at base, very erect, unequal, long and short intermingled.

HAB. Golden Gate, *Capt. Pike*. (50 in part, 78.) (v. s. in Herb. T. C. D.)

Frond 3 or 4 inches high, and as much in the expansion of the branches, stipitate, distichously branched in a palmato-flabelliform manner for a short distance above the base. *Branches* half a line to a line in breadth, compressed, sometimes nearly flat, sometimes approaching terete, very irregular in position, spreading, sub-simple and rather naked in the lower part, closely branched and repeatedly divided above. Lesser branches opposite, alternate or secund, small and large branches irregularly consecutive, somewhat pinnate, once or twice compounded. *Ramuli* very frequently secund, of very unequal lengths, filiform or setaceous, acute, very erect. *Colour*, a brown-red. *Substance*, cartilaginous and firm. *Fruit* unknown. A cross section of a small branch is a narrow ellipse, somewhat attenuated at the ends of the longer axis; there is a large central or axial tube, and two or more lesser tubes in the line of the longer axis; there is a narrow rim of minute, peripheric cells, and the whole of the interior space is filled with minute, endochromatic cells, being the cross cutting of longitudinal filaments. A longitudinal section shows a central long-jointed filament; a thin periphery of two other rows of minute coloured cells; and the intervening space formed of a very dense plexus of longitudinal filaments passing off towards the periphery into an imperfectly defined stratum of small, angular coloured cells. The central tube easily escapes observation in a longitudinal slice, unless the cutting be exactly through the middle of the frond.

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SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE.

NEREIS

BOREALI-AMERICANA :

OR,

CONTRIBUTIONS TO THE HISTORY OF THE MARINE ALGÆ
OF NORTH AMERICA.

BY

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PART III.—CHLOROSPERMEÆ.

[ACCEPTED FOR PUBLICATION, SEPTEMBER, 1857.]

COMMISSION
TO WHICH THIS PAPER HAS BEEN REFERRED.

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DR. ASA GRAY.

JOSEPH HENRY,
Secretary S. I.

SUB-CLASS III.

CHLOROSPERMEÆ, OR GREEN ALGÆ.

DIAGNOSIS. *Plants* almost always grass green ; rarely olivaceous, or lurid purple, still more rarely red. *Propagation* either by simple cell-division ; by the transformation of the colouring matter of the cells of the whole frond, or of some of the cells, into *zoospores* ; or rarely by ordinary *spores* developed in proper spore-cases. *Antheridia*, containing spermatozoids, have been observed in some. *Marine, or living in fresh-water streams, ponds, and ditches, or in damp situations.*

It is difficult, in a few words, to give such a diagnostic character of the Algæ included in this sub-class as shall comprise all the exceptional cases. The general *idea* of the group is that it shall contain Algæ of a herbaceous or grass green colour, propagated by zoospores, or by the transformation of some considerable portion of the whole of the endochrome into spores, without these spores being developed within proper spore-cases, distinct from the ordinary cells of the frond. In the great majority of these plants both characters are found ; but some few genera and species which agree with the rest in the dispersed fructification, or in being propagated by zoospores, are of a purple or red colour, thereby approaching the Rhodosperms in appearance ; while others are olivaceous, and thus seem to approach the Melanosperms. It does not appear to be desirable, for the mere variation in colour, to separate plants which are in other respects so closely allied as are the *Porphyra* to the *Ulvæ*, or the red *Palmellaceæ* to those of a green colour. It would be necessary, were we to remove these aberrant genera and species to the Rhodosperms, to construct special Orders to receive them, nor could we place these new Orders in the series of Orders as at present constructed ; but must establish for them a new division of the sub-class, which would be characterised by the absence of cystocarpic fruit and of tetraspores ; that is to say, by the absence of the fructification common to the whole of this sub-class. Thus it would appear that these purpurascent Algæ are more removed from *true* Rhodosperms, notwithstanding the red colour of their spores, than from Chlorosperms ; and consequently we retain them in this division. A graver anomaly, as it appears to me, occurs in the genera which produce *spores* of the ordinary character (not *zoospores*) contained within proper cysts. These have been removed by Endlicher and others to the Melanospermic sub-class ; and certainly they show a considerable approach to that group. But on the other hand, in the characters of their vegetation, in the structure, habit, colour, and general aspect of the frond they are so closely united to true Chlorosperms, that I am unwilling to separate them ; particularly as they do not seem to be equally nearly related to true Melanospermeæ. These exceptional genera were formerly included in *Siphonææ*, and are in this work separated under the name *Dasycladææ*.

The Chlorosperms are decidedly the lowest or simplest in structure not only of the Algæ, but of all plants. A very considerable number of them have the frond composed of a single utricle or cell, and all cell-division in such plants issues in the production of new unicellular fronds. The Orders *Diatomaceæ* and *Desmidiaceæ*, of which some hundreds of genera, and perhaps thousands of species are now known to Botanists, are of this character. In the whole of these, the frond consists of what may be called a bivalve cell; the primordial utricle being single while the cellular envelope is divided into two halves by a medial line. When such a cell is about to be multiplied by dividing into two, the two halves of the old cell remain unchanged, and a new growth of two new half-cells originates at each side, along the medial line. While this growth is going on, the old half-cells are gently pushed asunder, and when it is completed, a separation takes place, and two new fronds float apart, each of them composed of an old half-cell and a new growth which gradually acquires all the characters of the opposing valve. But the unicellular structure is not confined to such minute *atoms* as the *Diatomaceæ*, or such imperfect organisms as the *Protococcus* and its allies. Many of the larger Chlorosperms are essentially unicellular, and in some of these the vegetable cell is found of very much larger size than in any other plants. In *Codium*, *Vaucheria*, and *Bryopsis* single cylindrical cells may be obtained several inches in length, and frequently of considerable diameter. In *Valonia*, saccate cells sometimes as large as a walnut and often as large as a hazel nut, are found. *Botrydium*, a little siphonaceous Alga common on damp ground in Europe, exhibits within the compass of a single branching cell all the ordinary organs of a compound vegetable, as much specialized as is possible within such narrow limits: thus, it has a descending axis or root, an ascending axis or stem, and a vesicular body, within which its spores are developed. In *Caulerpa*, however, if the frond in that genus be really constructed by the evolution of a single cell, we have the vegetable cell assuming its highest development and attaining gigantic size. These unicellular (?) fronds are sometimes two feet in length, and excessively branched; with specialized root, stem, branches, and leaves.

The ordinary fructification of the Chlorospermeæ consists of *zoospores*, or spores endowed with ciliary motion, which have already been spoken of in the General Introduction, (Part I. pp. 13–14). These are usually of very minute size, and are formed within the cells of the frond, by the transmutations of the whole cell-contents. Myriads of moving granules are thus evolved, each of which is pointed at one end, and there furnished with two or four vibratile hairs, which act like oars, and drive the granule through the water. In one instance (*Hydrodictyon*) the zoospores, whilst still retained within the walls of the mother-cell, arrange themselves into a young frond, which issues from the cell perfect in all its parts. But usually they are dispersed in the water, and swim about until they commence germination. In some cases, a solitary zoospore and that of large size, clothed all over its surface with cilia, is formed from the mass of endochrome of the parent-cell. And often, as in *Zygnema* and its allies, the spore is the result of the union of the matter of two cells.

Among the more interesting observations recently made on the development of these Algæ, Pringsheim's memoirs on the fertilization of their spores by means of spermatozooids are specially worthy of notice. Male organs of unquestionable character have

now been discovered in several, leading to the inference that they exist in all. In some cases the spermatozoids are directly formed within the cells of the frond, from which they are dispersed in the water, and find their way to the enlarged cell in which the nucleus of the future spore, or rather *sporangium*, is contained, and which they penetrate, and effect the fertilization of the contents. In other cases there are formed within the cells of the frond and emitted into the water, solitary male-producing bodies resembling zoospores in form, but of smaller size, to which Pringsheim gives the name *androspores*. These *androspores*, after swimming freely for some time, like the zoospores, affix themselves (in *Ectogonium*) to the surface of the enlarged cell containing the female nucleus, or in its immediate neighborhood; and then develop into minute frondlets, consisting of two or three cells, the lowest of which contains endochrome, and acts as a mother-cell, while the uppermost becomes an *antheridium* in which spermatozoids are formed. After a time both the female-cell and the antheridium open at the summit; the spermatozoid is liberated and enters the aperture of the ovarian cell and fertilizes the enclosed nucleus; from which there results the large, immoveable spore characteristic of the genus. The whole process is described and its various stages elaborately figured in Pringsheim's memoir, republished in a French translation in *An. Sc. Nat.* 4th ser., vol. 5, p. 250, t. 15, to which I must refer for a fuller account. A previous memoir by the same author in *An. Sc. Nat.*, vol. 3, describes the fertilization of the spores of *Vaucheria* by an analogous process. Various memoirs have also recently appeared by Thuret, and by Derbes and Soliere, describing the process of the fertilization of the spores, and the development of the frond in other classes of the Algæ; and from the large number of species which have been investigated by these excellent observers, we may perhaps be warranted in drawing the general inference, that a process of fertilization, by two opposing sexes, exists in all the Algæ. It certainly exists in the Melanosperms, Rhodosperms, and in many of the inferior Chlorosperms. There is much variety, however, in the appearance of the *antheridia* in different classes; in some no spermatozoids have yet been discovered, in others they are of considerable size, and very active and well formed. In some cases each spore is separately fertilized; in others it is a body which afterwards develops spores. One important observation has been made by Pringsheim which is specially interesting from its bearing on the disputed question of the origin of the embryonic vesicle in the higher plants, namely, that in no instance has he observed any growth to proceed from the spermatozoid, but that its function seems to have been performed when its contents have mixed with those of the nucleus; the spermatozoid itself being wholly absorbed and dissolved in the mass.

Much still remains to be done in tracing the development of these Algæ, more especially in studying the transformations which many of them undergo. Very many have two or three different modes of re-producing the species, as by self-division, by zoospores or gemmæ, and by properly fertilized spores; and the individuals resulting from these various modes of growth are not always similar. Thus there is in many an "alternation of generations," to be studied, such as has been noticed among lower animals; and probably when the subject has been properly worked out, a large number, not only of species, but of genera, especially among the fresh water kinds, must be erased from our lists. It now appears probable to Pringsheim that many of the minute

unicellular Algæ of Braun are the male organs or *androspores* of other Algæ. I think it can hardly be questioned that multitudes of the Palmelloid forms are either spores or imperfectly developed fronds ; and the same is probable of many Confervoids. As yet the subject, except in a few able hands, has been confused rather than rendered more clear by the labour bestowed by authors upon it. There has been too great an anxiety to establish new genera and species, without due regard being had to circumstances of growth and development ; and the unfortunate student who now attempts to study the fresh water Algæ is oppressed by an accumulating mass of bad species and genera, which all have to be in some degree mastered before he can make *clean work*. Add to this, that in the present state of our knowledge it is absolutely necessary, in most instances, to have the living plant at hand, and it will be understood what a difficult task it must be to give a good account of the Chlorospermatus series of the Algæ.

No one can be more sensible than I am myself of the very imperfect nature of the sketch attempted in the present memoir. I write at a distance from my subject, and have rarely had more than dried specimens to examine. Though many of them were personally collected by myself in 1850, when travelling in America, on very few have I preserved notes taken from the recent plant. This is perhaps of less account among the marine kinds, which formed the staple of my personal collections, for the marine species recover their characters on re-immersion much more perfectly than the fresh water kinds. But the want of living specimens has seriously barred my attempts to describe the fresh water species, with the exception of such easily preserved kinds as *Hydrodictyon*, *Batrachospermum*, *Lemanea*, *Petalonema*, &c. The Zygnemaceæ, of which I have received several, and which are probably numerous in America, so completely lose their distinctive characters in drying, that I have been forced to omit them altogether. So also it has happened with the species of *Oscillatoria*, and of the Confervoid Algæ generally. I must therefore leave the task of describing the fresh water Algæ of America to other hands ; to some one living among them, and having eyes fully open to the difficulties of his task, and zeal and ability to work it faithfully. And here I cannot omit a slight tribute to the memory of one in whom were combined in no common degree the qualifications which make an able naturalist, and who, had he lived, would probably have taken up the broken thread.

I allude to the late Professor J. W. BAILEY of Westpoint, one of the earliest explorers of American Algæ, and whose very able memoirs on the *Diatomaceæ* have won for him an imperishable name in the annals of science. To me his loss is more personal than to most of his botanical friends, for from the hour we first met there grew up between us a warm friendship which death has interrupted, but which I trust it has not ended. He it was who first suggested to me a Memoir on the American Algæ ; he arranged with the Smithsonian Institute the terms of its publication ; he supplied me with a multitude of specimens ; and to his influence I owe the assistance I have received from many American algologists who looked up to him for direction in their studies. He was, as far as the Algæ are concerned, my chief American referee, to whom I could apply when seeking information on local matters, connected with this branch of study. With him I constantly associated my work, and to his approbation I looked forward as

the most grateful reward of my labours ; and now that he is removed, my interest in the work has sensibly flagged, and I am not sorry that it is brought to a conclusion.

Since the previous part was issued, two other of my correspondents have been numbered with the dead—Professor TUOMEY of Alabama, and Dr. BLODGETT of Key West, to both of whom I was indebted for very valuable contributions of specimens. Many of these have been noticed in the two former parts, and several more will be found described in the present. It has given me a melancholy pleasure to perpetuate the memory of the assistance I obtained from these gentlemen, by giving their names to the only new genera described in the present part.

Whilst thus I have to deplore the loss of a dear friend, and of two of my most valued correspondents, I have to acknowledge obligations to two new contributors of specimens, Mr. SAMUEL ASHMEAD of Philadelphia, and Mr. A. D. FRYE of New York. From Mr. Ashmead I have received a collection of the Algæ of New Jersey, and a very interesting series of those of Key West, including some new species ; the most remarkable of which are a new *Caulerpa*, and a new and very beautiful *Dasya*. To Mr. FRYE I have to return my thanks for a collection of the Algæ of California, very well prepared, communicated to me through Professor Henry in 1854 ; and to this gentleman I also owe an apology for not having mentioned his name in a previous notice of Californian Algæ, which were sent to me by Captain Pike of New York in 1852, and which I supposed had been collected by him. A letter addressed by Mr. Frye to Professor Henry, and forwarded to me since the publication of the notice referred to, informs me that the packet of Californian Algæ attributed to Captain N. Pike was collected by Mr. Frye, and indeed formed part of a fasciculus exhibited by Mrs. Frye at the American Institute in 1851, and for which she obtained a gold medal. There were several other exhibitors at the fair, but Mrs. Frye's were considered the most rare. "After the close of the fair," says Mr. Frye, "I furnished Mr. Pike with a large number of specimens which I collected in California. He professed to send them to Professor Harvey of Dublin, stating to me that he would send them in my name, and that I should be credited for them in Professor Harvey's work. In looking over the work I found Professor Harvey received a collection of Californian Algæ, and they were credited to Captain Pike. I was told by Mr. Pike and other algologists in New York that mine was the only collection they had ever seen or heard of from the Pacific, and I had made the first collection in California. This, I think, after making much enquiry is correct, as I cannot find that there has as yet been any brought from thence except mine, which I collected with my own hands. I exhibited them to the ladies where I was then boarding, at Jones's Hotel in San Francisco : they afterwards borrowed them to show at their parties, and sent a gentleman, Mr. W. Ball, to purchase 20 specimens for 20 dollars—which I furnished to them, and also spent several days in teaching him how to collect and prepare them. I should be glad if Professor Harvey could know the facts, as I think he would be glad to give me credit for the specimens." Justice to Mr. Frye compels me to give these facts as much publicity as my former erroneous notice has obtained. The plants were sent to me by Captain Pike, without mentioning any other person, and I naturally supposed they had been collected by himself. Nor did I hear of Mr. Frye as a collector of Algæ, until his letter, quoted above, was received on my return from

Australia in 1856. I now take the earliest opportunity of acknowledging the merit of his package, and trust that he will acquit me of any intentional suppression.

Should I be favoured with any further donations of specimens from America, I trust that I may be correctly informed of the circumstances under which they were obtained. Justice shall then be fully done to the merits of the collectors. The Algæ of the Pacific coast have as yet been very imperfectly explored, and probably many curious and beautiful species, still unknown to botanists, remain to reward the future exertions of Californian collectors. Possibly, in the collections of those Californian ladies and gentlemen mentioned by Mr. Frye, new species remain undescribed and unrecorded ; and should these remarks meet the eye of any one possessed of such things, and who may wish to see them duly published, I shall be glad to receive and acknowledge all contributions of Algæ if sent to me through Professor Henry or Professor Asa Gray : and the donors may rest assured that all such communications will be faithfully acknowledged.

W. H. H.

TRINITY COLLEGE, DUBLIN,
1 Dec. 1857.

SYNOPSIS OF THE ORDERS OF CHLOROSPERMEÆ.

1. SIPHONÆÆ. *Rooting* or basifixed. *Fron*d simple or compound, formed either of a single, filiform, branching cell, or of many such cells united together in a spongy frond. (*Marine or fresh-water.*)
2. DASYCLADEÆ. *Rooting*. *Fron*ds consisting of a simple or branched inarticulate axial thread, whorled with articulated ramelli. *Spores* spherical, developed in proper fruit-cells. (*Marine.*)
3. VALONIACEÆ. *Rooting*. *Fron*ds polymorphous, formed of large vesicated cells, filled with watery endochrome. (*Marine.*)
4. ULVACEÆ. *Basifixed*. *Fron*ds tubular or flat, membranous, formed of minute quadrate cells. (*Marine or in fresh water.*)
5. BATRACHOSPERMEÆ. *Basifixed*. *Fron*ds filiform; the axis inarticulate, composed of minute cylindrical or polygonal cells, naked, or whorled with articulated ramelli. *Spores* in moniliform strings, naked. (*In fresh water.*)
6. CONFERVACEÆ. *Basifixed* or floating. *Fron*ds filamentous, articulated. *Endochrome* diffused. *Zoospores* minute, formed in all the cells. (*Marine or in fresh water.*)
7. ZYGNEACEÆ. *Floating*. *Fron*ds filamentous, articulated. *Endochrome* of some definite figure. *Zoospores* large, formed by the union of two endochromes (of different cells), or by the bisection of a single endochrome. (*In fresh water.*)
8. HYDRODICTYÆÆ. *Floating*. *Fron*d forming a net-work with polygonal meshes; each side of the mesh formed of a single cell. *Viviparous*. (*In fresh water.*)
9. OSCILLATORIACEÆ. *Basifixed* or free. *Fron*d formed of subsimple filaments, having a membranous inarticulate tubular sheath, enclosing an annulated medulla, composed of very short, lenticular, cellules.
10. NOSTOCHINEÆ. *Basifixed* or free. *Fron*ds consisting of moniliform jelly-coated threads, free or enclosed in a gelatinous matrix.
11. DESMIDIACEÆ.* Microscopic, unicellular, green; wall of the cell membranous: growth by semisection of the cell, and the evolutions of two new half-cells at the medial line.
12. DIATOMACEÆ.* Microscopic, unicellular, yellow-brown; wall of the cell silicious: growth and fructification as in the preceding Order.
13. PALMELLACEÆ. *Cells* globose, or ellipsoidal, free, or lying in a gelatinous matrix, not forming either threads or membranes. *Propagation* by division of the endochrome.

* These Orders are not included in the present work. The North American species have been ably worked out by the late Professor J. W. Bailey of Westpoint, whose numerous memoirs on the subject have a world-wide reputation. The species are all of microscopic size, and some of them, from their extreme minuteness, and the delicate sculpturing on their cell walls, form admirable *test-objects* for microscopes.

ORDER I.—SIPHONACEÆ.

Siphonaceæ and Caulerpeæ, Grev. *Alg. Brit.* p. 183. *J. Ag. Alg. Medit.* p. 17. *Endl. 3rd Suppl.* p. 16. *Dne. Class*, p. 32; (also *Halymedææ, Dne.*) *Lindl. Veg. Kingd.* p. 18, and *Vaucherieæ*, in part, p. 22. *Vaucherieæ, Caulerpeæ, Codieæ* (in part), *Kütz. Sp. Alg.* pp. 486, 494, 500.

DIAGNOSIS. Green, marine or fresh water Algæ, naked or coated with carbonate of lime, composed either of a single, filiform, branching cell, or of many such cells united together into a spongelike frond.

NATURAL CHARACTER. *Root*, where it is developed, formed of many branching fibres interwoven together and entangled; sometimes penetrating deeply into the sand in which the plant grows, and attaching itself to the separate grains of sand, which serve further to consolidate the mass of fibres. *Frond* very variable in appearance, and differing much in complexity of structure, but always formed of very long, branching, inarticulate filaments, which arise from the continued growth and evolution of a single, undivided cell. In the genera of simplest structure, such as *Bryopsis* and *Vaucheria*, the frond consists of a single branching filamentous cell, with a thin, membranous, hyaline cell-wall; its cavity being filled with a granular semifluid colouring matter or endochrome, which may be wholly discharged if the tube be wounded and slightly pressed. In *Bryopsis* the unicellular fronds stand apart from each other, though many often rise nearly from the same base. In *Vaucheria* several such fronds are interwoven together at the base, but remain distinct in their upper branches. In *Chlorodesmis* there is a further union of many such threads, whose lower portion unite together to form an evident stipes or trunk, which is crowned with a pencil of free filaments; the whole frond resembling a little tree. This habit, however, is not so obvious in the American species as it is in *Ch. comosa*, the first described species of the genus. Again, in *Codium*, we find a structure essentially the same as in *Vaucheria* and *Chlorodesmis*, but the union of the filaments is still more intimate. To the naked eye, the species of *Codium* resemble green sponges or pieces of green cloth or velvet, having a perfectly definite outline and closely interwoven substance, and it is only when we tear or cut them asunder under the microscope that we perceive their true structure. We then find that all the central part of the substance of the frond is composed of innumerable interwoven, longitudinal branching cells, and that the velvety pile which constitutes the surface is formed of the tips of excurrent branches of the axial cells, lying close together and presenting only their extremities to the eye. In all

these genera the component filaments remain in the ordinary state of cellular tissue, having their membranous walls composed of cellulose, and filled with endochrome. The only further change which the plants of this group exhibit in structure consists in a secretion of carbonate of lime, which in several genera is found coating the external surface of the cells; and sometimes, as in *Halimeda* and some species of *Udotea*, surrounding the cells in such abundance as to cover the whole frond with a smooth coat of plaister, and obliterate all appearance of filaments. In such cases it is necessary, in order to see the structure, to macerate a portion of the frond in hydrochloric acid, until the lime be removed. When so treated, the component cells may be extracted and will be found to be of similar nature to those of *Codium* or *Bryopsis*. Indeed through some species, such as *Udotea membranacea*, there is an almost direct passage into *Codium*.

A more compound structure exists, as will be afterwards more fully described, in the sub-order *Caulerpeæ*, where from the inner face of the cell-wall innumerable branching and anastomosing processes issue, and fill up the cavity of the cell with a spongy, filamentous substance, unlike any structure noticed within the cavity of any other vegetable cells; so far as I am aware. On this remarkable character several authors propose to separate these plants into a distinct Order, and to this proceeding my only objection is that it appears to be an unnecessary multiplication of Orders.

The fructification of these Algæ has been observed in several but not in all, and presents some modifications in the different genera. In some, as in *Bryopsis*, the whole substance of the endochrome in fruiting specimens is changed into minute *zoospores*, which when emitted from the parent have an apparent voluntary movement like that of infusoria; swimming backwards and forwards by means of retractile cilia, which only disappear when the zoospore finds a point of fixture, and commences to germinate. In others, as in *Codium*, similar zoospores are developed within special encysted fruit-cells or vesicles, called by Agardh *coniocystæ*, which arise from the branches and are divided by a diaphragm from the branch on which they are formed. In others, as in *Vaucheria*, zoospores of a higher development are formed within similar cysts; and in this genus the cyst (or ovary) is accompanied by a well formed *antheridium*.

The process of fertilization of the spore in *Vaucheria* has recently been ably investigated by Pringsheim, a French translation of whose memoir on the subject will be found in Ann. Sc. Nat. Ser. IV. vol. 3, p. 363. The existence of two organs in *Vaucheria*, one of which was supposed to be an antheridium, had been noticed originally by Vaucher half a century ago, and they have passed under the eyes of succeeding observers; but no one appears to have actually watched the process of fertilization until it was discovered and published by Pringsheim in 1855. I shall merely give an abstract of the process, referring for full particulars, illustrated by beautifully executed figures, to the above quoted memoir. The *anther* or *corniculum* in *Vaucheria* consists of a small, cylindrical spirally curved or helicoid process rising from one of the branches of the frond, and at first not differing from an ordinary branchlet except in size. But gradually a change takes place in its contents, at first manifested by a loss of colour in the matter filling the upper portion of the young antheridium. Then a diaphragm is formed, which walls off the portion toward the extremity of the antheridium from the

lower half, which retains its union with the branch : and now the change is complete. The anther thus formed consists of an isolated, curved, cylindrical, nearly colourless but not empty cell, supported on a pedicle of variable length and curvature. In the anther-cell spermatozoids are gradually evolved out of the contained matter, and are at maturity emitted through an opening at the summit of the cell. So much for the structure of the anther. The *sporangium*, or female organ, is placed on the branch close to the *antheridium*, and like it, at first consists of a papilla, or minute ramulus rising from the branch. It does not, however, lengthen into a cylinder, but assumes an ovoid form ; its contents become dense and granular ; a diaphragm separating it from the branch is formed across its base, and thus it becomes a separate egg-shaped cellule, sessile on the branch from which it has been formed. A beak-like attenuation, directed toward the adjacent antheridium, is now formed, and becomes at length perforated. At the same time the antheridium, having curled round, directs its extremity toward the sporangium ; its summit opens, and the enclosed spermatozoids are discharged into the water, close to the orifice of the sporangium, which they enter and effect the fertilization of the matter aggregated within. A cell-wall is then formed round the fertilized substance, which thus becomes a spore, which gradually ripens and is detached on the bursting or decay of the membranous cyst within which it was formed. In its process toward ripening it loses its green colour, and at length becomes nearly colourless, except for one or more brown masses which it contains. In this state it remains, often for a considerable time, till germination takes place, when it suddenly resumes its green, and then elongates into a tubular cell, which assumes the form and ramification of the parent plant.

This Order is dispersed, under one or other of its forms, over most parts of the world, and its species are found either in the sea, in fresh water, or occasionally on damp soil ; some species of *Vaucheria* and the curious little *Botrydium* being terrestrial. The geographical range of several species is very extensive. *Codium tomentosum* and *Bryopsis plumosa* are common to the Northern and Southern Oceans and to the Eastern and Western Hemispheres, and are both found in the warmest parts of the tropical seas, as well as in high latitudes of the temperate zones. *Caulerpa* is specially characteristic of the tropical ocean, where its species are numerous, some of the more common kinds forming the principal algoid covering of rocks or sands in shallow water. Some of its species are widely scattered, and others apparently limited to a few spots. Several of the fossil algoid plants appear to have been *Caulerpæ*, and the fossil figured by Brongniart (*tab. 9, bis, fig. 1*), under the name "*Fucoides hypnoides*," bears a very striking resemblance to *Caulerpa hypnoides* of the Australian coast.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

Sub-order I. CAULERPEÆ. *Fronde* with prostrate, rooting, primary stems (*surculi*), and erect branches, membranous, unicellular ; cell within filled with a network of branching fibrils.

I. CAULERPA.

Sub-order II. CODIÆ. *Frond* uni- or pluri-cellular. *Cells* filled with granular endochrome (without internal fibrous network).

* *More or less coated with carbonate of lime.*

II. HALIMEDA. *Frond* branching, articulate ; the joints flattened.

III. UDOEA. *Frond* stipitate, fan-shaped, simple or cleft.

** *Destitute of carbonate of lime, soft and flaccid.*

IV. CODIUM. *Frond* spongelike, of definite form, composed of closely interwoven, irregularly branching filaments.

V. CHLORODESMIS. *Frond* stipitate (or sessile), pencil-shaped, composed of dichotomous filaments, interwoven at base, and free in their upper portion.

VI. VAUCHERIA. *Filaments* numerous, tufted and somewhat matted at base, free above, irregularly branched.

VII. BRYOPSIS. *Filaments* free, tufted or solitary, pinnately branched.

I. CAULERPA, Lamour.

Frond consisting of prostrate *surculi*, rooting from their lower surface, and throwing up erect branches (or secondary fronds) of various shapes. *Substance* horny-membranous, destitute of calcareous matter. *Structure* unicellular, the cell (or *frond*) continuous, strengthened internally by a spongy network of anastomosing filaments, and filled with semi-fluid grumous matter. - *Fructification* unknown.

The genus *Caulerpa* was founded by Lamouroux in 1810, and referred by him to his family of Ulvaceæ, though with doubt ; for he seems to have thought the structure of these plants so anomalous that he hesitates to pronounce them vegetables, notwithstanding their strictly vegetable form, immobility, and green colour. He had not, however, made himself master of their real structure, for he describes the frond as "consisting of an epidermis, and a cellular tissue consisting of cells so small that it has been impossible to determine their form" (*Ess.* p. 67). Turner appears to have been the first author who noticed the fibrous spongelike network which fills up the cavity of the membranous frond. This he describes under his *Fucus hypnoides*, but in terms which show that he supposed this structure peculiar to that species. To Dr. Montagne we owe the first and best account of the structure of the *Caulerpæ*. This able algologist, in a paper read before the French Institute in 1837 and published in *An. Sc. Nat.* for March, 1838, has given a full history of the genus, both as to its organization and what he believed to be its fructification. To this memoir I refer the reader who wishes for full information of all that was then known of these plants, and shall content myself in this place with briefly describing their habit, structure, and geographical distribution.

The character seized on by Lamouroux as essential to a definition of the genus, and happily indicated by him in the name *Caulerpa* (derived from *χαυλος*, a stem, and *ἔρπω*, to creep) consists in the prostrate, primary stems or *surculi* in which the frond originates, and which are furnished at intervals throughout their length with branching and fibrous roots that penetrate deeply into the sand in which the plant vegetates, or attach themselves firmly to the rock in such species as grow on rocks and corals. These roots are fibrous prolongations of the under surface of the prostrate stems, and are probably, notwithstanding their great development, chiefly useful for fixing the plant in its position. From the upper side of the *surculi* rise erect branches or secondary fronds, which are very various in form, and are either sessile or supported on stalks or *stipites* of greater or less length. Some recent writers on these plants have proposed to divide the genus into several, assigning to them characters taken from the form and ramification of the branches; and those who wish to know what can be done in this way may consult a memoir by Count Trevisan in the 22nd vol. of Schlechtendahl's *Linnæa*, where subdivision is pushed to an extreme. I have not adopted these views of arrangement, being unwilling to break up what appears a natural assemblage, and thus needlessly to multiply generic names. By employing artificial characters it is very easy to split up any genus of several species, but unless the number of species included in a genus be inconveniently large, it seems undesirable to do so. The genus *Caulerpa*, as defined by Lamouroux, includes about fifty species which agree in all essential characters of structure and development. The differences among them are obviously of a very minor character, and though proper enough for the definition of sections, are we think of too trivial a nature to afford stable generic diagnoses. For instance, let us take one of the proposed new genera, *Corradoria*, which differs from another, *Chauvinia*, merely in having bifarious instead of multifarious leaves or ramenta. But the feebleness of this character is shown by several species which are imperfectly bifarious; so that bifarious and tri- or multifarious ramenta may occasionally be found on one and the same specimen. *C. cupressoides* of the North American coast has ramenta sometimes bifarious, sometimes trifarious; and *C. falcifolia* of the tropical Pacific, which is normally bifarious, is frequently quadrifarious on part of the same individual.

In all the North American species the ramenta are confined to the upright branches or secondary fronds, and the *surculi* are smooth and glossy except in *C. lycopodium*, where both the *surculus* and the stalks of the fronds are densely clothed with branching, woolly hairs. In several Australian and some Pacific species the *surculi* are equally ramentiferous with the fronds, though the ramenta they bear are often of a different shape. The forms and ramifications of the upright fronds are much varied. In our *C. prolifera*, the type of Kutzing's genus *Phyllerpa*, we have an example of membranous, expanded, leaflike, simple fronds, perfectly entire at the margin; in *C. denticulata* and *C. scalpelliformis* there are similarly flattened fronds, but deeply pinnatifid; in *C. mexicana* the marginal incisions are so deep that the frond becomes pinnate, and thus we are led, by easy transitions, to *C. taxifolia* and *C. plumaris* where the pinnate character is perfectly developed. Again, in *C. falcifolia*, Bail. & Harv. there is a passage from the species with pinnate fronds to those having filiform ramenta imbricated on all sides; for, as already mentioned, the ramenta on some of the fronds are strictly

distichous, and on others tristichous or quadrifarious. A further step brings us to *C. Selago*, *C. Lycopodium*, and their allies, in which the branches are thickly set with imbricating ramenta; and the highest development of this type is reached in *C. obscura*, *C. Muelleri*, and *C. hypnoides*, where pinnate and imbricated characters are combined. Another group of species, like our *C. paspaloides*, is characterised by having pinnate or multifid ramenta; and in another, the ramenta are baglike, either round, pyriform, or topshaped. Of this type we have an American example in *C. clavigera*, one of the most widely dispersed and most variable of the species. By depressing the apex of a baglike ramentum it becomes top-shaped, and by further depression peltate, and this form distinguishes *C. chemnitzia* and *C. peltata*; and again, peltate ramenta becomes perfoliate in *C. nummularia* and *C. stellata* by the development of young ramenta from the centre of the discs. In such species as *C. ericifolia* and *C. cupressoides* the gradual evolution of ramenta from mere prominent points of the frond is illustrated; and such species lead us to *C. Freycinetii* where the ramenta remain in this rudimentary condition. And thus we are conducted, by almost insensible gradations, through a considerable number of forms, back to those from which we started, and which had naked fronds destitute of ramenta or marginal incisions. And so, after a survey of all the species, we become more reconciled to the generic group as limited by Lamouroux, than if we had merely compared together such extreme forms as *C. prolifera* and *C. paspaloides*.

We have already said that the structure of all these plants is essentially the same. It remains to describe more particularly what that structure is. I am not aware that any observer has yet noted the early development of the frond, nor is the mode of reproduction as yet clearly made out. The spores are presumed to be similar to those of *Bryopsis*, and to be formed in any portion of the grumous matter that fills the frond, and most probably from that of the ramenta. When we take a fully formed frond, distinguishable into creeping stem, roots, upright branches and ramenta, we find that it is every where coated or encased in a homogeneous, hyaline, tough membrane destitute of further structure than this; that it may be seen in the thicker parts to be composed of several layers of cellulose, equally deposited one within another, as in the wood-cells of higher plants. There is no *septum* throughout the plant, and no appearance of cellular structure in the membrane of the walls. The frond, with all its ramifications, is strictly "*continuous*," forming a closed sac; and so far as we know it is formed by the evolution of a single cell, extending itself indefinitely without cell-division, and showing in excess the same structure as we find in a minor degree in such plants as *Botrydium*, *Bryopsis* and the like. This closed sac, frond or cell, in *Caulerpa*, is filled as in *Bryopsis*, with a semi-fluid, semi-gelatinous, bright-green endochrome containing starch-grains mixed with what seem to be oily particles, and obviously highly organized, but its chemical composition remains to be examined. Most probably it is highly nitrogenous, for it bears considerable resemblance in substance to the glairy semi-fluid of many sponges; and hence probably the reason of Lamouroux's supposition that these plants were of a semi-animal nature. If the structure of *Caulerpa* were merely what we have described, a closed membrane filled with grumous matter, it would not essentially differ from that of *Codium* and *Bryopsis*.

But there is found in *Caulerpa* a supplementary structure of a very peculiar and curious kind, which has induced several systematic writers to separate this genus, as the type of a family distinct from the other Siphonææ. An unwillingness needlessly to multiply families, and a belief that *synthesis*, much more than *analysis*, ought to be the study of a system framer, has prevented my adopting these views. The structure alluded to is this : from the inner face of the wall of the membrane covering the frond there issue innumerable, cylindrical, filamentous processes, which seem to be merely internal extensions of the cell walls, and not new cells. These branch and anastomose together into a kind of spongy net-work that fills the whole cavity of the frond, and is bathed and its fibres keep apart by the grumous fluid. This spongy net-work may be regarded as the proper frame-work of the plant, intended to give strength and unity to all parts of the frond. The filaments appear to be tubular, but are empty and colourless. This peculiar modification of structure is so like that of a sponge, that we may almost regard a *Caulerpa* as a vegetable sponge enclosed in a membranous epidermis.

The genus *Caulerpa* is eminently characteristic of the tropical and subtropical oceans and seas of both hemispheres. Very few species extend far into the temperate zone. The most northern are found in the Mediterranean Sea ; and the most southern on the shores of New Zealand. Many species exist on the southern coast of Australia, in lat. 35° or 36° ; but the greater number are found within 35° of the equator. They inhabit the littoral zone, from near high-water to low-water marks ; and some extend into the laminarian zone, or even to that of the Nullipores. Their favorite locality is on hard sand, or on sand-covered rocks ; and in the crevices of coral on the coral reefs, and more particularly in hollows left on the surface of the reef, where the corals have ceased to grow. Most of the American species grow within tide marks, but are not luxuriant except at low-water mark, or a little below it. *C. clavifera* commences to grow nearly at high water mark, and is continued throughout the whole littoral zone and into the laminarian. It consequently varies greatly in size and in general aspect, and accordingly appears under several names in botanical works ; but these "book-species," however distinct they may look in the herbarium, cannot be recognized on the shore, where all the forms gradually blend together. Some of the species are very local. Others are found in both hemispheres, and in the Atlantic and Pacific Oceans. Of the North American species *C. plumaris*, *C. clavifera*, *C. ericifolia* and *C. cupressoides* are the most widely dispersed, being found in all tropical waters ; *C. prolifera* is found in the Mediterranean Sea ; *C. paspaloides* on the coast of Brazil, while *C. Ashmeadii* and *C. lycopodium*, so far as is yet known, are peculiar to the Keys of Florida. *C. mexicana* very closely resembles *C. asplenoides*, Grev. a native of the Indian Sea, and it is questionable whether these are distinct ; and *C. lycopodium* also is nearly allied to *C. selago*, a native of the Red Sea, but appears to be essentially characterised by its woolly stems. The Red Sea, the Persian Gulf, the shores of tropical Asia and those of New Holland, with the coral reefs of the Pacific furnish many local species, some exceedingly curious and beautiful. Several species are eaten by the natives of the Pacific archipelagoes ; and all furnish a favourite food to the turtle, whose green fat they serve to nourish.

We shall distribute the nine American species into three sections, characterised as follows :—

Sect. 1. PHYLLERPA. Kütz : *Fronds* plano-compressed, or flat, leaflike, very entire.

1. CAULERPA *prolifera*, Lamour.; surculi naked, glabrous; fronds erect, petiolate, flat, leaflike, nerveless, entire, tongue-shaped, rarely once forked, proliferous from the disc or apex. *Lamour. Ess. p. 67. Ag. Sp. Alg. 1, p. 444. Trevis. in Linn. vol. 22, p. 129. Phyllerpa prolifera, Kütz. Sp. Alg. p. 494. Fucus Ophioglossum, Web. and Mohr. Turn. Hist. t. 58. (TAB. XXXVIII. B.)*

HAB. Keys of Florida, on submarine sands. Key West, *W. H. H.*, No. 95. *Mr. Ashmead. Soldier's Key, Professor Tuomey*, No. 83 in part. (v. v.)

Surculi prostrate, throwing out from their under surface branching and fibrilliferous roots, simple or branched, twice as thick as hog's bristle, glabrous, glossy, cylindrical, shrinking, and longitudinally channelled when dry. *Fronds* stipitate, the *stipes* filiform, from a quarter-inch to an inch in length, of equal diameter with the surculi, compressed at the apex, and gradually passing into the base of the oblong or obovate, tongue-shaped obtuse lamina. The *frond* or lamina is flat and leaflike, two to four inches long, from half to three-quarter inch wide, either quite simple or once forked, with a perfectly entire flat margin. Occasionally similar stipitate fronds spring proliferously from any point of the disc or from the base or apex, especially if the latter has been wounded. The *substance* is membranaceous, somewhat horny and translucent, with a very glossy surface when dry. The *colour* is a full grass-green, becoming oil-green and variously tinged with yellow in a dried state. It does not adhere to paper in drying.

This species is rather rare at Key West. My specimens were picked up on the beach, after a southerly gale in the month of February. They closely correspond with specimens from the Mediterranean Sea, where, as well as in the subtropical Atlantic, this plant is not uncommon. *C. prolifera* has a very different habit from the other American species, but is closely related to the Australian *C. parvifolia*, and to *C. anceps* from the coral reefs of the Pacific. It appears to be still more closely akin to *C. costata*, Kütz, a Mediterranean species unknown to me, and said to differ in having a semi-nerved lamina.

PLATE XXXVIII. B. *Fig. 1. CAULERPA prolifera; the natural size.*

SECT. 2. PTILERPA. *Fronds* plano-compressed, inciso-serrate, pinnatifid or pinnate.

2 CAULERPA *Mexicana*, Sond.; surculi naked, glabrous; fronds erect, sessile, pinnato-pinnatifid; rachis (broad), plano-compressed; pinnæ opposite, vertically

flattened, two-edged, oblongo-falcate, mucronulate, scarcely constricted at base, their margin entire. *Sonder in Kütz. Sp. Alg. p. 496. (TAB. XXXVII. A.)*

HAB. Keys of Florida, on submarine sands and sand covered rocks. Key West, *W. H. H. (No. 94.) Professor Tuomey, No. 72. Mr. Ashmead. (v. v.)*

Surculi prostrate, extensively creeping, rooting from their under surface, branched, twice as thick as hog's bristle, glabrous, glossy, longitudinally furrowed when dry. *Fronds* springing from the upper surface of the *surculi*, nearly sessile, or on very short stipites, broadly linear (in outline), 4–6 inches long, $\frac{1}{4}$ – $\frac{1}{2}$ inch wide, either simple or with one or two branches, pinnate or rather very deeply pinnatifid, from just above the base to the bifid or emarginate extremity. *Rachis* plano-compressed, from one to two lines wide, somewhat thick and fleshy when recent, horny and longitudinally rugulose when dry, closely set throughout with the opposite, distichous pinnæ. *Pinnæ* from two to four times as long as broad, patent, the lower ones somewhat ovate, the upper gradually more and more oblong and incurvo-falcate, vertically flattened, two edged, mucronulate, entire; the margin quite free from denticulations. *Substance* when dry horny, membranaceous and glossy, semi-transparent. *Colour* a brilliant grass green, variously tinged with yellow, and becoming slightly olivaceous when dry.

This beautiful plant abounds at Key West, particularly under the bridge, where it forms widely spreading patches. *Sonder's* specimens were sent from Mexico, but the exact locality is not given. It is nearly related on the one hand to *C. denticulata*, *Dne.* from the Red Sea; and on the other to *C. asplenoides*, *Grev.* (in *An. Nat. Hist. vol. 12. tab. 1. f. 1.*) a native of the East Indies, if indeed that species be really different. It also bears much resemblance to *C. taxifolia*, *Ag.*, but the pinnæ are broader, more sharply two-edged, and distinctly mucronulate.

PLATE XXXVII. A. *Fig 1. CAULERPA Mexicana*; the natural size. *Fig. 2, a pair of pinnæ, magnified.*

3. *CAULERPA plumaris*, *Ag.*; *surculi* naked, glabrous; fronds erect, subsessile, distichously pectinato-pinnate; rachis (narrow) filiform; pinnæ opposite, slender, filiform, setaceous, incurved, or subfalcate, either acute or sub-obtuse. *Ag. Sp. Alg. 1, p. 436. Kütz. Sp. Alg. p. 496. Bory, Voy. Coq. tab. 22, f. 4. Corradoria plumaris, Trevis. in Linn. 22, p. 133. Fucus taxifolius, Turn. t. 54 (excl. syn.) Fucus plumaris, Forsk. (TAB. XXXVIII. C.)*

Hab. Sandy shores, on the Florida Keys. Key West, *W. H. H., Professor Tuomey, Mr. Ashmead, (v. v.)*

Surculi prostrate, rooting from the under surface, a line or more in diameter, branched, glabrous, glossy, collapsing, and becoming longitudinally furrowed when dry. *Fronds* numerous, rising from the upper side of the *surculi*, erect, simple or with one or two

branches, scarcely stipitate or subsessile, linear (in outline), 2-6 inches long, less than half an inch wide, pectinato-pinnate from a short distance above the base to the extremity. *Rachis* filiform, scarcely thicker than hog's bristle, closely set with pinnæ. *Pinnæ* opposite, sometimes a little obliquely inserted, setaceous, 2-3 lines long, rarely straight, generally more or less incurved or falcate, their apices sometimes very acute, ending in a sharp mucro, sometimes bluntish. *Substance* when dry horny and semitranslucent. *Colour* a deep and rather dark green, the tips of the pinnæ often yellowish or orange.

A native of the tropics generally, both of the eastern and western hemisphere; occasionally straggling into the warmer parts of the temperate zone. It varies much in the diameter of the surculi, and somewhat in the length of the pinnæ, but is easily recognised by the closely pectinate fronds, which resemble small green feathers. The specimens from Key West are peculiarly robust, and if compared with some slender varieties from the Pacific, might pass for different. But at Vavau, in the Friendly Islands, where this plant is common, I collected specimens both of the robust and slender form.

Plate XXXVIII. C. Fig. 1. *CAULERPA plumaris*, the natural size. Fig. 2, a pinna, magnified.

4. *CAULERPA Ashmeadii*; surculi naked, glabrous; fronds erect, shortly stipitate, distichously pectinato-pinnate; rachis subcompressed; pinnæ opposite (or suboblique), erecto-patent, straight, linear, somewhat incrassated at the very obtuse extremity. (Tab. XXXVIII. A.)

Hab. Key West, rare. *W. H. H., Samuel Ashmead, Esq.* (v. v.)

Surculi prostrate, distantly rooting, one or two lines in diameter, glabrous and glossy, collapsing, and mostly channelled when dry. *Fronds* scattered, rising from the upper side of the surculi, erect, each furnished with a stipes from half an inch to upwards of an inch in length, and closely pectinato-pinnate throughout. Each frond, pinnæ included, is about an inch in breadth, and from four to six inches in length. The pinnæ are half a line in diameter, three-fourths of an inch long, terete, and nearly linear, but more or less thickened towards the extremity, which is very obtuse, without trace of mucro or acumination. The substance when dry is horny and semi-transparent. The colour, when recent, is grass green, but in drying it turns to olive.

The roots, Mr. Ashmead remarks, penetrate so deeply, and fix themselves so firmly in the hard sand, that it is with difficulty obtained, except in fragments. I regard the present as a distinctly marked new species, and have much pleasure in inscribing it to Mr. Samuel Ashmead of Philadelphia, a gentleman who has already made some interesting discoveries among the Algæ at Key West, and from whom many more may be expected. It is a much larger and stronger growing plant than *C. plumaris*, and remarkable for the very obtuse and almost club-shaped ends of the nearly straight pinnæ.

Plate XXXVIII. A. Fig. 1, *CAULERPA Ashmeadii*, the natural size. Fig 2, a pinna, magnified.

SECT. 3. CHAUVINIA, Bory ; *Fronds* terete, simple or branched, set with tri-multifarious, leaflike, saccate, or thornlike ramuli (*ramenta*).

5. CAULERPA *clavifera*, Ag. ; surculi naked, glabrous, robust ; fronds erect, simple, short or elongate, more or less densely set on all sides with scattered, clubshaped, pyriform, or nearly topshaped ramenta. *Ag. Syst.* 1. p. 437. *Chauvinia clavifera*, Kütz. *Sp. Alg.* p. 498. *Ahnfeldtia racemosa*, A. Lamourouxii, and A. uvifera, Trevis. l. c. pp, 141-142. *Fucus clavifer*, Turn. *Hist.* t. 57. *F. Lamourouxii*, Turn. t. 229. *F. uvifer*, Turn. t. 230.

HAB. Sand covered rocks, about low-water mark, and at a greater depth. Key West and Sand Key, W. H. H., *Professor Tuomey* ; Conch Key and Key Biscayne, *Professor Tuomey* (v. v.)

Surculi robust, glabrous, glossy, one or two lines in diameter, spreading in dense mats, copiously supplied on the under surface with dense, excessively divided, fibrous, and deeply penetrating roots. *Fronds* erect, crowded, varying very much in length, according to the depth of water at which the plant grows, and from other circumstances affecting its luxuriance. Sometimes the erect portion of the frond is scarcely an inch in length, sometimes it is six, eight, or even ten inches long. It varies also in diameter from half a line to a line or more, and is more or less densely set on all sides with scattered, incrassated, very obtuse saccate ramenta. In the variety called *Lamourouxii* these ramenta are inserted in a distant spiral so as to look almost distichous ; in other varieties, and especially in that called *uvifer*, they are densely crowded and inbricated, like grapes in a cluster. Numerous intermediate forms connect these extreme ones. The shape of the ramenta is also very variable. When young, they are simply clavate ; but with advancing age they become more and more swollen at the ends, and at length are pear-shaped, or, in some stunted specimens, top-shaped. Stunted specimens somewhat resemble *C. sedoides*, and have been mistaken for that species, which, however, differs in several respects.

This plant is common to the tropics of both hemispheres, and is particularly abundant on the coral reefs of the Pacific, where it puts on many different forms, and varies much in luxuriance. It is one of the species eaten as a salad by the natives, and some of the European residents, of the Friendly and Feejee Islands, who call it *Limu* (Lee-moo). I cannot consent to separate specifically the forms figured by Turner, and above indicated as varieties. I fear also that *C. oligophylla*, Mont., if I rightly understand that species, must be regarded as an extreme form, nearly destitute of ramenta. I gathered what I take to be Montagne's plant at Vavau, in the Friendly Islands, where its peculiarities seemed to arise from the circumstances of its habitat, which was in a very rapid tide-stream between two islets.

6. CAULERPA *Lycopodium* ; surculi and stipites of the fronds tomentose with brand-

ing hairs ; fronds erect, stipitate, scattered, simple or slightly branched, densely set on all sides with imbricated, erect, setaceous, acute, or mucronulate ramenta. (TAB. XXXVII. B.)

Hab. On sand-covered rocks at Key West, abundant, *W.H.H.* (v.v.)

Surculi prostrate, widely creeping and rooting from the lower side, everywhere densely clothed with woolly, branching hairs, which are slightly viscid and collect particles of sand ; the whole mass of *surculi* forming a dense mat. *Fronde* rather distantly scattered, erect, stipitate. *Stipes* 1–2 inches long, filiform, tomentose, the hairs branching. *Fronde* simple, or rarely once-forked, two to four or six inches long, very densely beset on all sides with slender, setaceous, erect, incurved, imbricated, acute, or mucronulate simple ramenta, which are two or three lines long, and nearly of capillary diameter. *Substance* somewhat horny when dry. *Colour*, a deep and rather a dull green, paler in the *surculi* and stipites.

I had at first taken this plant for *Caulerpa Selago*, but Turner expressly says of that species that the creeping stems or *surculi* are “smooth, shrinking, and wrinkled when dry ;” whereas in our Key West plant they are everywhere densely clothed with branching, woolly hairs. His figure (*Hist. Fuc. t. 55*) also represents the fronds as sessile, or ramuliferous to the very base. With no other species can the present be confounded. *C. Selago* is a native of the Red Sea. Two Australian species, *C. Brownii* and *C. furcifolia*, have been sometimes confounded with it, but in both of these the *surculi* are clothed with ramuli resembling those of the erect branches.

PLATE XXXVII. B. *Fig. 1.* CAULERPA *Lycopodium*, the natural size. *Fig. 2.* whorled ramenta in situ. *Fig. 3.* a ramentum, detached. *Fig. 4.* portion of the woolly stipes. *Fig. 5.* branching hairs from the same. The latter figures more or less magnified.

7. CAULERPA *ericifolia*, Ag. ; *surculi* robust, naked and glabrous ; frond shortly stipitate, irregularly much branched ; branches scattered, repeatedly divided, clothed on all sides with short, ellipsoidal, succulent, mucronulate, erecto-patent ramenta, set in 3, 4, or 5 ranks. *Ag. Sp. Alg. 1, p. 442.* *Chauvinia ericifolia*, Kütz. *Sp. Alg. p. 497.* *Trevis. l. c. p. 137.* *Fucus ericifolius*, Turn. *Hist. t. 56.* (TAB. XXXIX. A).

HAB. Key West, *W. H. H.* Conch Key, *Prof. Tuomey.* (v. v.)

Surculi prostrate, robust, as thick as crow quill or thicker, branched, extensively creeping, glabrous, glossy, shrinking and deeply channelled longitudinally when dry, rooting from the under surface ; the roots distant and very long, branched and fibriliferous. *Fronde* erect, scattered, with short, simple or forked stipites, much and irregularly branched ; branches scattered, once, twice, or thrice compounded, very erect, as are also all their lesser divisions, all the angles being close and acute ; ramenta densely set, tri-, quadri-, or quinquefarious, short, somewhat intricate, the lowermost

reduced to mamillæform tubercles, the upper more perfectly formed, ellipsoidal, saclike, and mucronulate. The branch, including its ramenta, is not more than a line in diameter. The substance is rather rigid, and is horny when dry. The colour is dull green, inclining to olivaceous.

I have much doubt whether this plant, which was originally described and figured by Turner, be permanently distinct from the following, of which it has very much the habit, but from which it differs, at least in typical specimens, by the more numerous rows of the ramenta and their more ellipsoidal shape. Specimens however vary in both these respects, and I could be well content to unite both forms under one specific name.

PLATE XXXIX. A. *Fig. 1.* CAULERPA *ericifolia*, the natural size. *Fig. 2,* small fragment of a branch with its ramenta. *Fig. 3,* a ramentum; the latter figures magnified.

8. CAULERPA *cupressoides*, Ag.; surculi robust, naked and glabrous; frond shortly stipitate, irregularly much branched; branches scattered, once or twice compounded, set with short, conoidal, mucronate, sub-bifarious or bifarious ramenta. *Ag. Sp. Alg.* 1, p. 441. *Chauvinia cupressoides*, Kütz. *Sp. Alg.* p. 497. *Trevis. l. c.* p. 137. *Fucus cupressoides*, *Esper. t.* 161. *Turn. Hist. t.* 195. (TAB. XXXIX. B.)

HAB. Key West, with the preceding. *Prof. Tuomey.* (v. v.)

Except in the less imbricated, di-tristichous, and shorter ramenta, this species does not differ from *C. ericifolia*. But these characters are variable. If the two species be united, the name *cupressoides*, as the older, must be preserved. Both forms are natives of the West Indies, and of the Pacific Ocean. *C. ericifolia* was first brought from Bermuda; and *C. cupressoides* from St. Croix.

PLATE XXXIX. B., *Fig. 1.* CAULERPA *cupressoides*, the natural size. *Fig. 2,* apex of a branch with tristichous ramenta. *Fig. 3,* portion of another branch with distichous ramenta. *Fig. 4,* a ramentum; the latter figures magnified.

9. CAULERPA *paspaloides*, Bory.; surculi robust, naked and glabrous; fronds with a long naked stipes, flabellately branched, the branches once or twice forked, or simple, fastigiate, densely beset in 3 or 4 ranks, with plumose, patent or recurved ramenta; ramenta sub-bipinnate, pinnæ opposite turned to one side, subulate or mucronulate, mostly pectinated with similar mucronulate pinnules on their inferior sides. *Chauvinia paspaloides*, Bory, *Coq. p.* 205, *tab.* 23, *fig.* 1. Kütz. *Sp. Alg.* p. 500. *Trevis. in Lin.* 22, p. 137. *Caulerpa Wurdemanni*, Harv. MS.—Var. β ; ramenta simply pinnate, the pinnæ very long and straight, destitute of pinnules.

HAB. Key West, abundantly. *Dr. Wurdemann, W. H. H., Prof. Tuomey, Mr.*

Ashmead. Conch Key and Key Biscayne, *Prof. Tuomey*.—Var. β cast ashore at Key West. *W. H. H.* (v. v.)

Surculi prostrate, robust, sometimes nearly as thick as a goose's-quill, sometimes as a crow-quill, glabrous, glossy, shrinking much in drying and becoming longitudinally furrowed, vaguely branched, rooting at intervals of one or two inches; the root long, branched, and fibrilliferous. *Fronds* rising from the upper surface of the *surculi*, scattered, on long, glabrous, naked stipites, flabelliform in outline, pedate or digitate, the branches spreading, simple or forked, fastigiate, densely set throughout with imbricated, four or five-ranked *ramenta*. *Ramenta* one to four lines long, varying much in length and somewhat in ramulification on different specimens. Normally they are patent or recurved and sub-bipinnate, or pinnate with pectiniform pinnules; that is, the *ramentum* is oppositely pinnate, the *pinnæ* closely set, straight, subulate, or filiform, mucronulate, and furnished along one (the lower) side with unilateral *ramuli* of similar form. In different specimens the number and development of the processes of the *pinnæ* vary; sometimes they are 5 or 6, and of considerable length; sometimes but 2 or 3, and these very short. In var. β they are absent altogether, and the *ramenta* of much greater length than is usual in var. α ; but I have seen specimens so completely intermediate that I dare not make two species of these seemingly different forms, particularly as both occur in the same locality. The normal form has been admirably figured by Bory in the plate above quoted. I fear that *C. phlæoides* of that author can only be regarded as a variety of the present species.

II. HALIMEDA. *Lamour.*

Root fibrous, much branched. *Frond* erect, dendroid, branching, articulato-constricted, with flattened internodes (or *articulations*), coated with a smooth calcareous crust, and composed internally of a plexus of longitudinal, sub-parallel, unicellular, branching filaments. (These filaments, which constitute the medullary stratum of the compound frond, are constricted at intervals, and at each constriction emit a pair of opposite, horizontal, di-trichotomous, corymbose *ramelli*, whose apices cohere together into a false epidermis or periphery.)

The species comprized in this genus were placed by Ellis and Linnæus in the genus *Corallina*, where they remained till 1812, when Lamouroux very properly separated them to form the present group. The resemblance to *Corallina* is merely external. Both genera have jointed fronds, encrusted with calcareous matter, but here the resemblance ceases. The structure, colour, substance and fructification, which determine affinities, are widely different in *Corallina* from what they are in *Halimeda*. In this

latter genus, after the lime has been removed by acid, there remains a plexus of unicellular, branching filaments, filled with green endochrome, and essentially of the same structure and nature as those of *Codium*. In *C. Opuntia* these filaments are easily extracted, and may readily be pulled asunder; in *C. Tuna* they adhere more closely and require to be carefully manipulated. The *Halimedæ*, like the *Caulerpæ*, are confined to the warmer portions of the globe, and are particularly abundant on coral reefs, in both hemispheres. As many as thirteen species are described by authors, but several appear to have been founded on very insufficient data; and probably they might be reduced by one-half. *C. Opuntia* is the most widely dispersed, being found abundantly in the tropical Atlantic and Pacific, and in the Mediterranean and Red Seas. *C. incrassata* and *C. Tuna* occur in the Pacific as well as in the Atlantic, but are less universally dispersed than *C. Opuntia*. When seen in herbaria the species are frequently bleached white, but all are of a bright grass-green when growing. They are furnished with deeply descending, fibrous, much branched roots, whose capillary rootlets firmly grasp particles of sand, and with them form a solid ball, not easily broken asunder.

1. HALIMEDA *Opuntia*, Lamour.; frond very much branched, diffuse; articulations reniform, flat, obscurely lobed or repando-crenate along the upper margin. *Lamour. Exp. Meth.*, p. 27, t. 20, fig. 6. *Dne. Cor.* p. 90. *Kütz. Phyc. Gen.* t. 43, fig. 2. *Kütz. Sp. Alg.* p. 504. *Corallina Opuntia*, *Ellis and Sol.* p. 110, t. 20, fig. b. *Ellis, Cor.* t. 25, a. (TAB. XL. B.)

HAB. On rocks and in tide-pools, near high water mark, on the Florida Keys. Key West, *W. H. H.*, *Prof. Tuomey.* (v. v.)

Root deeply descending, fibrous, densely compacted into a fusiform mass, 1–2 inches long. *Stems* very numerous from the crown of the root, weak, but supporting each other by their proximity, and thus forming very dense tufts, much and irregularly branched; the branches spreading. *Articulations*, except one or two of the basal ones, which are oblong or cylindrical, broadly reni-form, the more normal ones twice as broad as their length, from $\frac{1}{8}$ to more than $\frac{1}{4}$ inch across, flat, rather thin, but much incrusted with calcareous matter, with a more or less evident or obsolete longitudinal ridge through the middle; the superior margin somewhat repando-crenate or lobed. After the calcareous matter of the frond has been removed by acid, a spongy vegetable structure remains, made up of a plexus of slender, longitudinal, unicellular filaments, constricted at intervals, and at the constrictions emitting a pair of opposite, decom-pound, dichotomous, corymboso-fastigiate, horizontal ramelli, whose apices cohere together, and form a thin epidermal or peripheric stratum of cells, over the surface of the frond. When the surface is viewed vertically, the cohering tips of the ramelli appear like the areoli of a continuous membrane. The substance of the filaments is tough, and they are filled with green matter. No fructification has been observed.

PLATE XL. B. *Fig. 1.* HALIMEDA *Opuntia*, the *natural* size. *Fig. 2*, portion of the branching, unicellular filaments of which the frond is composed ; *magnified*.

2. HALIMEDA *incrassata*, Lamour. ; fronds solitary, erect, fruticose, somewhat flabelliform, much branched ; articulations thickened, the lowermost compresso-terete, quadrate ; the middle cuneate ; the upper (mostly) compressed, obscurely repando-crenate. *Lam. Exp. Meth. p. 25. Lam. Polyp. p. 307. Dne. Cor. p. 91. Kütz. Sp. Alg. p. 504. Corallina incrassata, Ell. and Sol. p. 111, t. 20, d.—Var. β, monilis ; all the upper branches moniliform, composed of small, roundish, beadlike articulations. H. monilis, Lx. Dne., Kütz., &c. Corallina monilis. Ell. and Sol. p. 110, t. 20, Fig. C.*

HAB. Florida Keys. Key West, *W. H. H.* (chiefly var. *β*). (v. v.)

Root a globose or oblong, bulblike, fibrous mass. *Stems* generally single, with a short, undivided, compressed or subterete *bole* (or *stipe*) composed of two or more incrassated and confluent articulations ; then expanding and divided into numerous branches, which are repeatedly di-, tri-, or polychotomous at short intervals, spreading generally in one place and thus forming a flabelliform frond. In the lower part of the frond the articulations are very thick and almost confluent, a slender line merely defining the limits between each ; they are oblong or quadrate, and more or less cylindrical. The middle articulations are more cuneate and less confluent ; and the upper ones, in typical specimens, are still flatter and somewhat crenato-lobate. In the variety most common at Key West, and which constitutes the *H. monilis* of authors, the upper branches are slender and moniliform, composed of small, globose, or truncate, thick articulations of variable size, and somewhat varying in form, the terminal ones on a branch being frequently cuneate. The structure of the frond is similar to that of *H. Opuntia*.

Both varieties, as indicated above, are excellently figured by Ellis and Solander, and by them and succeeding authors are kept as distinct species. Lamouroux indeed observes (*Pol. flex. p. 307*) that the characters attributed to each are frequently confounded on the same specimen. This I find to be the case in specimens collected at Key West, and I have, therefore, united the two forms under one specific name.

3. HALIMEDA *tridens*, Lamour. ; frond solitary, erect, flabellately branched ; articulations compressed, the lower ones quadrate or oblong ; the middle cuneate ; the upper three lobed or tri-crenate. *Lam. Exp. Meth. p. 27. Pol. Flex. p. 308. Dne. Cor. p. 91. Kütz. Sp. Alg. p. 505. Corallina tridens, Ell. and Sol. p. 109. Tab. 20, fig. a. (TAB. XLIV. C.)*

HAB. Key West, *Prof. Tuomey*. (v. s.)

Fronds solitary, erect, with a cuneiform stipes composed of several confluent articulations and dividing at the summit into numerous branches, which soon again subdivide in a di-poly-chotomous manner, all the branches lying in one plane, so as to form a flabelliform frond. The articulations are all compressed, the middle ones more or less cuneate; the upper usually tridentate or three-fingered, and frequently bearing articulations from the summit of each lobe. *Colour* rather a bright green. *Calcareous* incrustation thin.

This is nearly related to *H. incrassata*, and perhaps only a variety. But the crust is not so dense, and the distinctly three-lobed upper articulations are characteristic. Ellis's figure correctly represents a small branch.

PLATE XLIV. C. *HALIMEDA tridens*; the *natural* size.

4. *HALIMEDA tuna*, Lamour.; frond much branched, diffuse, di-trichotomous; articulations flat, thin, very broad, roundish or somewhat reniform, mostly entire; the middle ones sometimes cuneate. *Lamour. Pol. Flex. p. 309, t. 11. fig. 8. Dne. Cor. p. 91. Kütz. Sp. Alg. p. 504. Corallina Tuna, Ell. and Sol. tab. 20, fig. e. Hal. platydisca, Dne. ? p. 90. (TAB. XL. A.)*

HAB. Key West, *W. H. H.* Key Biscayne, *Prof. Tuomey.* (v. v.)

Root deeply descending. *Stipes* scarcely any, consisting of a single, cuneate or flabelliform articulation, which is sometimes more than an inch across, from the upper margin of which spring numerous other articulations, forming the bases of so many irregularly dichotomous branches. The articulations vary much in form and size. Their usual shape is roundish or sub-reniform, and they are from half to $\frac{3}{4}$ inch broad, quite flat, smooth, and thinner than in most species. They are joined together by very much constricted nodes, and are usually broader than their length. In some of my specimens, however, some of the medial articulations are narrow-cuneate or almost clavate. There is less incrustation in this species than in most; the colour is a bright green, and the substance somewhat flexible.

The original *H. Tuna* is a native of the Mediterranean; and possibly the plant now described may be referable to *H. platydisca*, Dne., but some of my Key West specimens so closely resemble what I have received from the Mediterranean, that, habitat apart, I cannot find a character to distinguish them. Others are certainly of larger size, with more discoid articulations. If, however, every slight variation in form and size is to be made the foundation of a new species, and dignified with a special description and name, the number of species to be established would only be limited by the number of specimens examined; for scarcely two are to be found identical at all points.

PLATE XL. A. *HALIMEDA Tuna*, the *natural* size.

III. UDOTEÆ. *Lamour.*

Root fibrous, much branched. *Frond* erect, stipitate, expanded, flabelliform, more or less incrustated with calcareous matter, concentrically zoned, composed internally of a plexus of longitudinal, subparallel, unicellular, branching filaments. *Sporangia* "lateral, globose." (*Kütz.*).

The genus *Udotea* is intermediate between *Halimeda* and *Codium*, differing from the former in habit and from the latter in having the filiform cells of which it is composed incrustated with carbonate of lime. The amount of incrustation varies much in different species. In *U. flabellata*, which very closely agrees in structure with *Halimeda*, the calcareous matter forms a solid, smooth, and somewhat polished crust, completely concealing the filaments of which the frond is constructed; in *U. conglutinata* the lime forms a thin coat round each individual filament, but does not conceal the filamentous structure of the frond; and in *U. Desfontanesii* there is scarcely any calcareous deposit, and except in habit the plant is almost a *Codium*, in which genus it was placed by Agardh. Ten species of *Udotea* are known, all of them natives of the warmer parts of the sea. Our *U. flabellata* is found in the Indian Ocean, and I have received *U. conglutinata* from Port Natal, S. Africa.

1. *UDOTEÆ flabellata*, Lamour.; stipes simple, short, terete or sub-compressed, expanding into a broadly flabelliform, simple or lobed, wavy, concentrically zoned, smooth frond; the margin either quite entire, undulato-repand, crenate, or deeply lobulate, sometimes proliferous; surface thickly incrustated; concentric zones evident, closely set or sub-distant. *Dne. Cor. p.* 93. *Lamour. Pol. Flex. p.* 311. *Kütz. Sp. Alg. p.* 502. *Corallina flabellata*, Ell. and Sol. *Cor. p.* 124. tab. 24 (*excellent!*).

HAB. Key West, *W. H. H.* Abundant between Key West and Cape Florida, *Prof. Tuomey.* (v. v.)

Root a fusiform mass of intricately interwoven fibres, one to two inches long. *Stipes* half an inch to an inch long, terete, a quarter-inch or more in diameter, simple, erect, terminating in the broadly cuneate or reniform base of the frond. *Frond* sometimes six inches across, but our specimens are mostly smaller, usually broader than its length, more or less cuneate at base, the lateral margins prolonged downwards in old fronds, which, therefore, are somewhat reniform; flabellate, either quite entire with a flat margin, or more frequently undulate, lobed at the margin or deeply divided (as Ellis's figure represents) into numerous lacinia, which take the form of the primary frond, and imbricate each other at the edges. The surface is thickly coated with a calcareous crust, and quite smooth; it is marked at short, but very uncertain intervals, with concentric lines or furrows, much more obvious in some specimens than in others, but always to be found. The substance is as thick as calfskin and leathery to the touch.

The *structure*, after removal of the lime, is seen to consist of closely packed, parallel, longitudinal, unicellular filaments, branching and interlaced together, and emitting toward the surface, or periphery, short, horizontal, rootlike, fastigiate, branching processes, of whose cohering apices the surface of the frond is composed. *Colour*, a pale grass green, bleaching to a dirty white.

2. *UDOTEA conglutinata*, Lamour. ; stipes short, simple, smooth, expanding into a broadly flabelliform, simple or lobed, flat, scarcely incrustated, strigose frond, composed of longitudinal, parallel, agglutinated, dichotomous filaments, constricted at the furcations. *Lamour. Pol. Flex. p. 312. Kütz. Sp. Alg. p. 502. Corallina conglutinata, Ell. and Sol. p. 125, t. 25, fig. 7. Udotea Palmetta ? Dne. p. 93. (TAB. XL. C.)*

HAB. Key West, *W. H. H.* (v. v.)

Root deeply descending, long and fibrous. *Stipe* terete or compressed, about half-an-inch to $\frac{3}{4}$ inch long. *Frond* flabelliform, 1–2 inches broad, flat, cuneate or cordate at the base, either entire or somewhat lobed, or irregularly torn, but slightly incrustated with lime ; the filaments of which it is composed being everywhere visible, and giving to the surface a strigose, fibrous appearance. These filaments are longitudinal, parallel, conglutinated together, but readily separable when the lime has been removed by acid. They are dichotomous, constricted at the forkings almost as if jointed, very slender, and destitute of lateral horizontal annuli, or of rooting processes. They more resemble the threads of a *Codium* than of a *Udotea*, and may almost be compared to those of a *Penicillus*.

I have not seen any authentically named specimen of Solander and Ellis's plant, but have little or no doubt of the correctness of my reference. The strigose or filamentous surface at once distinguishes our plant from *C. flabellata* ; and Solander truly observes, " We can plainly distinguish all the dichotomous branches" (filaments) " of this Coral-line on its surface, which are each of them separately covered with a thin calcareous substance full of pores ; these, by growing so close to one another, become glued or united together by their covering."

PLATE XL. C. *Figs. 1, 2, and 3. UDOTEA conglutinata*, different varieties, the natural size. *Fig. 4.* Portions of the branching, unicellular, constricted filaments of which the frond is composed ; *magnified.* *Fig. 5.* Small portions of the same, more highly *magnified.*

IV. CODIUM. *Stackh.*

*Fron*d sponge-like (globular, cylindrical or flat ; simple or branched) composed of a plexus of unicellular, branching filaments, filled with green semifluid endochrome. *Sporangia* lateral, on the ramuli of the filaments (forming the surface of the frond), and containing innumerable zoospores.

The frond in this genus, though it assumes a well-defined shape, characteristic of the particular species, does not form a solid, compact body as in *Udotea*, but consists altogether of innumerable slender, unicellular, branching filaments, inextricably interlaced or woven together. In the centre of the filamentous mass these filaments are threadlike, branching at longish intervals, curled or sinuous, filled with slimy fluid, and only partially supplied with green colouring matter. In the elongated species, as in *C. tomentosum*, these axial filaments take a longitudinal direction ; in the globose ones they radiate from a central point, as in the singular *C. mammillosum* of Australia; and in the incrusting species, like *C. adhærens*, they spread horizontally over the surface of the rock on which the plant grows. In all cases they throw out more or less club-shaped ramuli, which spread in a direction vertical with the surface of the frond, and their apices lying close together, but not cohering, constitute the periphery. There is no calcareous incrustation as in *Udotea*, and no false epidermis as in *Hali-meda* ; but with these exceptions there is much similarity in structure. The external habit is remarkably varied. In *C. tomentosum*, the type of the genus, and the most widely dispersed species, the frond is somewhat cylindrical, and dichotomously branched ; in a form (or species ?) called *C. elongatum* a similarly branching frond is extravagantly dilated and flattened especially at the axils ; in *C. laminarioides* a stipitate frond suddenly expands into a flat lamina a foot or two across, resembling nothing so much as a piece of green friese-cloth ; in *C. amphibium* a number of minute papilliform branches rise from a flat adherent surface ; and in *C. adhærens* there is a flat, clothlike crust, destitute of branches, and indefinitely covering rocks and woodwork. In *C. bursa* the frond is sessile, gradually becoming globose and at length hollow ; and lastly, in *C. mammillosum* the frond is either exactly spherical or egg-shaped, composed of filaments radiating from a central point, and being, so far as known, destitute of any root-like attachment.

The fructification in *Codium* consists of an oblong, ovate *sporangium*, formed of a single cell, separated from the ramulus near the base of which it is developed, by a diaphragm, and containing, at first, a dense, dark-green endochrome, and finally a multitude of *zoospores*. These latter are ovate, of a deep green colour, with a minute "rostrum" at one end, which carries a pair of cilia, that serve as organs of locomotion till the spore becomes fixed and germinates. This fruit is exquisitely figured by Thuret, in his memoirs on the Zoospores of Algæ, in *An. Sc. Nat. 3rd Series, Bot. vol. 14, tab. 23*, where a full account of the evolution is given.

1. *Codium tomentosum*, Stack. ; frond linear, dichotomous, cylindrical or compressed. *Ag. Sp. Alg.* 1. p. 542. *Wyatt, Alg. Danm. No.* 35. *Kütz. Sp. Alg.* p. 500. *Harv. Phyc. Brit.* t. 93. *Fucus tomentosus*, *E. Bot.* t. 712. *Turn. Hist.* t. 135.

HAB. Apalachicola, *Captain Pike*. Manatee River, *Mr. Ashmead*. Key West, *W. H. H. Sitcha, Ruprecht*. California, *Dr. Coulter*. (Not received from the east coast). (v.v.)

Fronds rising from an expanded, velvety incrustation, solitary, or gregarious, from three inches to one or two feet in length, varying much in diameter, erect, dichotomous, with or without lateral accessory branches. *Branches* cylindrical or compressed, obtuse, clothed with hyaline, spreading, soft, byssoid hairs, which, when the plant is expanded in water, stand out vertically on all sides, and give to the branches the *tomentose* character commemorated in the trivial name. The *axis* is composed of innumerable, interwoven, irregularly branched, slender filaments, from whose sides issue radiating, horizontal, clubshaped ramuli, whose apices, closely placed, but not cohering, form the surface of the spongy frond. To the sides of these ramuli are attached the *sporangia*, which are oval or ovato-lanceolate, and subsessile.

It is a singular fact, (if it be *really* a fact) that this well-known and common species, which is found in every latitude from the Equator to the colder parts of the temperate zone, and nearly to the polar basin, is not a native of the *Eastern* coast of North America. It has not been sent to me by any of my correspondents from any part of the Atlantic coast, except from Florida, at the mouth of the Mexican Gulf. There I have myself gathered it. On the west coast it appears to be abundant, and extends as far north as Sitcha. There is nothing to distinguish Californian specimens from those found in Europe, in Ceylon, in Australia, at the Cape of Good Hope, or at Cape Horn, at all which places it is common.

V. CHLORODESMIS. *Bail. and Harv.*

Frond pencil-form, stipitate or sub-sessile, flaccid, without calcareous incrustation, wholly composed of cylindrical, dichotomous, unicellular filaments filled with dense, vivid-green endochrome. *Stipes*, when present, spongy, formed of interwoven threads.

The genus *Chlorodesmis* was founded by the late lamented Professor Bailey and myself on an alga brought by Captain Wilkes from the Feejee Islands, and which I have since collected abundantly on all the coral reefs which I had the opportunity of visiting in the tropical Pacific, where it forms a very striking object on the extreme outer edge of the reef. This original species—*C. comosa*, *Bail. and Harv.*—has a distinct, and

often elongate, spongy stipes, and a brushlike habit, not unlike that of a *Penicillus* ; and few algologists will question its claim to generic distinction. I am not quite sure that I do well in associating the following species in the same genus ; but I know not where else to place it, unless indeed in *Vaucheria*. The specimens, however, appear to be scarcely mature ; there is a resemblance in the colour and substance, and the habitat is not dissimilar ; and I am willing to think that more advanced specimens might exhibit more of the spongy stipe which forms the most tangible character of this genus. The fruit has not been observed.

1. CHLORODESMIS ? *Vaucheriæformis* ; stipes obsolete ; fronds sessile, comoso penicillate, fastigate, dark-green, composed of innumerable, slender, dichotomous, exceedingly lubricous and subgelatinous, unicellular, cylindrical filaments ; apices equal, level-topped, obtuse. (TAB. XL. C.)

HAB. On stones, at Brown's Wharf, Key West, W.H.H. (v. v.)

Stipes obsolete, consisting in a bulbous mass of interlaced, branching fibres, which throw up the erect and free filaments of which the frond is composed. These filaments form dense pencil-like tufts, about an inch high, and perfectly fastigate. They are exceedingly slender, cylindrical, of equal diameter throughout, dichotomous, obtuse, gelatinoso-membranaceous, soft, and very lubricous, and filled with a dense, deep-green endochrome. Each filament is strictly unicellular, without articulation or constriction.

Plate XL. C. *Fig. 1.* CHLORODESMIS *Vaucheriæformis* ; the natural size. *Fig. 2.* Portion of one of the branching unicellular filaments. *Fig. 3 and 4,* small portions of the same ; the latter figures *magnified*.

VI. VAUCHERIA. D.C.

Fronds densely cæspitose, and somewhat interwoven ; each consisting of a single, irregularly branched, unicellular cylindrical filament. *Cell-wall* very thin and delicate. *Endochrome* granular. *Sporangia* lateral, on the sides of the branches. *Antheridia* cylindrical, hooked, accompanying the sporangia.

The greater number of species of this genus occur in freshwater ponds, ditches, and streams, and probably several may yet be found in North America. I have received from Mr. H. W. Ravenel of South Carolina a specimen of a *Vaucheria* apparently allied to *V. dichotoma*, but not in a state to be recognised. It was found floating in limestone-waters. Dried specimens of this genus are rarely of any use, as the specific character is generally lost in drying.

VII. BRYOPSIS. *Lamour.*

Root fibrous. *Fronds* tufted, each consisting of a single, erect, branching, unicellular, cylindrical filament ; branches and ramuli either imbricated or pinnate. *Cell-wall* firmly membranaceous, glistening. *Endochrome* granular and viscid, at length converted into *zoospores*, which escape through apertures formed in the cell-wall.

This genus consists of several littoral Algæ of small size, but among the most elegant of marine plants. They occur in tufts, seldom more than two to four inches in height, and grow either on the rocky margins of clear tide-pools, or epiphytically on other Algæ. The frond is affixed to the rock by a slightly developed fibrous radicle, or simply by a disc, and consists of a single cylindrical elongated branching cell, filled with dense, starchy endochrome of a deep green colour, and destitute of any septum or interruption of the cavity throughout the whole length of the tube. The ramification is very generally on a pinnate type ; a primary undivided filament emits lateral virgate branches, also quite simple, and these are generally naked in the lower half of their length, and furnished with lateral, distichous or imbricated ramuli in the upper half. In some species, as in *B. Balbisiana*, there are either no ramuli or very few ; in others, as in *B. myura*, the ramuli are exceedingly numerous and densely set. Very many species have been named and described, with more or less care, by authors ; but many rest on very uncertain characters, and I fear that several must be regarded as mere varieties of *B. plumosa*, the original and most widely dispersed species. All are remarkable for a glassy lustre, when dry. They retain their colour, if carefully dried, and adhere closely to paper.

1. *BRYOPSIS plumosa*, Lamour. ; frond setaceous, decompoundly much branched ; the ultimate branches filiform, virgate, naked in their lower half, and more or less plumosopectinate above ; ramuli simple. *Ag. Sp. Alg.* 1. p. 448. *Harv. Phyc. Brit. tab.* 3. *Kütz. Syst. Alg.* p. 493. : *Ulva plumosa*, *E. Bot. t.* 2375.—Var. β . *densa* ; branches excessively crowded, the ultimate divisions pinnate near the apex, the pinnæ sometimes secund.—Var. γ *secunda* ; tufts matted ; fronds irregularly much branched ; branches flexuous, many of them naked, others set in the upper half with falcato-reflexed, secund (occasionally bilateral) ramuli. (Tab. XLV. A.) Var. δ ; *ramulosa* ; branches nearly naked, with a few scattered, secund ramuli. *Bryopsis ramulosa*. *Mont. Hist. Cuba*, p. 16. *Tab.* 3. *fig.* 2. (TAB. XLV. A.)

HAB. Between tide marks in rock pools. Various localities near New York, common. Charleston, South Carolina, and Key West. Vars. β , γ , and δ , intermixed with the ordinary form at Key West and Sand Key, *W.H.H.* (v. v.)

Root small, scutate, accompanied by lateral, entangled fibres, and sometimes matted.

Fronds 3-6 inches high, setaceous, much branched ; normally in a decompound pinnate manner, but very irregularly so. In what we may call typical or normal specimens, the outline of the frond is somewhat pyramidal, the lowest branches being very long and patent, the upper gradually shorter and more erect. In such specimens the branches are sometimes simply, sometimes doubly pinnate ; in either case the lower half of the branch or branchlet is bare, the upper plumose, with simple ramuli inserted in nearly distichous order. To describe every variety of ramification different from this, and commonly occurring in this species, would be an endless and useless task ; and worse than useless to found new species on such variations. I have endeavoured above to indicate the principal varieties which I have observed among American specimens. The var. γ *secunda* looks very like a distinct species, and had I seen none but carefully selected specimens, possibly I should have so regarded it ; but though many specimens may be found strictly conforming to the character assigned, having all their ramuli secund and recurved, others occur, growing intermixed with them, in which the ordinary ramulification is followed. At Key West I collected some specimens which I cannot distinguish from *B. ramulosa*, Mont., and which seem to pass through var. γ and other intermediate forms, into ordinary *B. plumosa*. Having received from Dr. Montagne himself an authenticated specimen of his plant, I can speak with more confidence.

Bryopsis plumosa, under one or other of its many forms, is found in most parts of the world, at least within the temperate and tropical zones. In Europe it occurs as far north as the Faroe Islands (lat. 65°). In the Southern Ocean it extends to Cape Horn, and the Falkland Islands, and to New Zealand. The *B. Rosæ* of the Southern Hemisphere seems to be merely a luxuriant form, and not a distinct species.

Plate XLV. A. *Fig. 1.* *BRYOPSIS plumosa*, var. γ *secunda* ; the natural size. *Fig. 2 and 3,* secund and bilateral plumules from the same ; *magnified.* *Fig. 4.* *B. plumosa*, var. δ *ramulosa* ; the natural size. *Fig. 5,* imperfectly pinnulate branch from the same, *magnified.* *Fig. 6,* apex of a branchlet, more highly magnified.

2. *BRYOPSIS hypnoides*, Lamour. ; frond setaceous, decompoundly much branched ; branches spreading to all sides ; ultimate branches filiform, naked below, beset above with scattered or crowded, irregularly inserted, very slender, byssoid, pinnated ramuli. *Grev. Alg. Brit. p. 180. Harv Phyc. Brit. tab. 119. Wyatt, Alg. Danm. No. 81. Harv. Man. p. 146. (quere Lam. Jour. Bot. 1809. p. 135 ?) B. cupressoides, Lam. fide I. Ag.*

HAB. Key West, W.H.H., Dr. Blodgett, Professor Tuomey. (v. v.)

Tufts dense, 4-6 inches high. *Fronds* setaceous, much branched, the branches issuing from all sides of a common stem or central filament, long and virgate, either quite simple, or bearing a second set of similar quadrifarious branches. These branches, as in *B. plumosa*, though sometimes ramulose nearly to the base, are generally naked in

their lower half, and beset with ramuli only above. The ramuli are exceedingly slender, many times more so than the part of the branch from which they spring, and are generally furnished with opposite or scattered, slender pinnules. The colour is a pale yellow green ; the substance exceedingly soft and tender.

The figure given in Phyc. Brit., taken from West of Ireland specimens, does not very well represent the Key West plant, which, however, closely resembles specimens from the South Coast of England and coast of Normandy, except that they are rather more luxuriant. This plant is generally of a much paler colour and still softer substance than *B. plumosa*, and is distinguished from the varieties of that plant by its *ramuli* being compound (pinnate), as well as greatly more slender than those of *B. plumosa*.

ORDER II.—DASYCLADEÆ.

Dasycladeæ and Polyphyseæ, Kütz. Phyc. Gen. p. 311–312. *Valoniææ*, in part. Kütz. Sp. Alg. p. 507. *Part of Siphonææ*, Auct. alior.

DIAGNOSIS. Green, marine Algæ, naked, or coated with carbonate of lime, having a unicellular simple or branched axis, which is whorled, either throughout its whole length, or near the summit, with articulated ramelli. *Spores* spherical, developed in proper fruit-cells.

NATURAL CHARACTER. *Root* formed of tubular, elongated, branching fibres more or less matted together. *Frond* either simple or branched, essentially consisting of an axis and of ramelli. The *axis* is in all cases a continuous tube, without articulation or septum, running throughout the frond, containing endochrome in a young stage, but very frequently found empty in the mature plant ; and is apparently formed by the evolution of a single cell. Its walls are thick, tough, and readily seen, when a cross section is examined under the microscope, to be composed of successive concentric layers of cellulose. At regular intervals, either throughout the whole length of the axis, or in its upper half only, the tube is pierced by a circle of holes, and from these holes there issue whorled, articulated, confervoid ramelli, which appear to discharge the functions of leaves, and are sometimes deciduous, sometimes persistent. In the less complex genera, *Polyphysa* and *Acetabularia*, the ramelli are extremely delicate and fugacious, and are found only on young plants, or during the process of evolution ; their position being indicated on plants from which they have fallen, by the circle of holes in which they had been inserted. In *Dasycladus* the ramelli are permanent, and thickly clothe every part of the stem, in whorls sometimes very closely placed, sometimes sub-distant ; but there is no connection among the ramelli or between the whorls. In *Neomeris* the structure of the stem and ramelli is very similar to that of *Dasycladus*, with this difference, that the apices of the ramelli cohere to form an investing membrane or epidermis

which completely encases the frond and conceals its filamentous structure. In *Cymopolia*, again, we have a still further advance in structure ; for, not to speak of its calcareous shells, every node of which the branching frond is composed may be compared to the whole frond of a *Dasycladus* or a *Neomeris*. Like them, it is a tubular axis whorled with ramelli ; but these latter are so closely placed together that the whorled character is not obvious, and the branch has the mammillated look of a *Codium*, if its calcareous shell be removed ; or of a piece of honeycomb, if viewed with the shell still remaining.

The *spores* are of large size, and are always formed within proper fruit-cells or sporangia, and, so far as I am aware, are destitute of vibratile cilia, and appear to be formed on a much more perfect type than ordinary zoospores. They have a tough, hyaline, membranous coat, and enclose a mass of dense, dark green or brown endochrome. In *Polyphysa* and *Acetabularia* the sporangia spring directly from the axial tube ; in *Dasycladus*, *Neomeris*, and *Cymopolia* they are found on the ramelli, and are either special cells, developed in the axils of the ordinary cells (as in *Dasycladus*), or are formed by metamorphose of a division of the ramellus, as in *Cymopolia*.

All the plants of this order, with the exception of *Dasycladus*, secrete carbonate of lime, but in very different proportions. In *Polyphysa* and *Acetabularia* the calcareous matter exists as a thin varnish to the surface of the stem ; but in *Cymopolia* it forms as complete a shelly envelope as it does in one of the calcareous polypes, and indeed a dead frond in this genus might readily be mistaken for the husk of a zoophyte : its honeycombed pores closely resembling polype-cells.

All the species are natives of the warmer parts of the sea. *Dasycladus* and *Acetabularia* have representative species in the Mediterranean ; and the latter is found also in the tropical Pacific. *Neomeris*, which may probably yet be detected on the Floridan Keys, has species in the West Indies and Pacific Ocean. *Cymopolia* is found in the Carribean Sea, and also at the Canary Islands. *Polyphysa* was discovered by Dr. R. Brown at King George's Sound, and has recently been found at Port Lincoln, Australia, by Mr. Wilhelmi ; and at Swan River, by Mr. George Clifton.

I am very unwilling to multiply families, especially among plants of such low organization as the Chlorospermatus Algæ, and yet I have been in a manner compelled to remove from the *Siphonaceæ* both the little group now described, and the following one (*Valoniaceæ*) ; from the impossibility of devising any diagnostic character which would include the whole. The true *Siphonaceæ* are typically known by being wholly formed of long, tubular branching cells. In the *Dasycladeæ* the axis only is of this character ; the rest of the frond consists, as in *Conferva*, of strings of short cylindrical cells ; and the *spores* are of a higher type than in *Siphonaceæ*. In *Valoniaceæ* tubular branching cells are found, if at all, only in the root, or in a spongy caudex, while the principal part of the frond is formed of confervoid filaments. They approach *Dasycladeæ* through *Chamædoris*, and possibly Kützing may be correct in associating them, as he has done in his latest arrangement, with this group ; but, ignorant as we are of their proper fructification, I have not ventured to adopt this course. The habit of the true *Valoniaceæ* is dissimilar, and in none of them do we find the ramelliferous internodes which characterise the present family.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

- I. CYMOPOLIA. *Frond* with a calcareous, branching, articulated shell ; the internodes honeycombed ; apices emitting pencilled ramelli.
- II. DASYCLADUS. *Frond* soft, unbranched, set throughout with closely placed whorls of trichotomous, horizontal ramelli.
- III. ACETABULARIA. *Frond* with a filiform, incrusting stipes, terminating in a peltate disc formed of radiating fruit-cells (*sporangia*.)
-

I. CYMOPOLIA. *Lamour.*

Frond filiform, dichotomous ; its outer crust (or shell) calcareous, thick, distinctly articulate, the articulations everywhere pierced with pores, and the younger nodes fringed with byssoid, multifid fibrillæ. *Inner frond* (enclosed in the crustaceous shell) a membranous, continuous branching hollow tube, nodoso-constricted and moniliform, but not septate ; the *nodes* when young fibrilliferous, at length bare ; the *inter-nodes* whorled with several rows of short, horizontal, 3-4-fid, club-shaped ramelli, which protrude through the pores of the outer crust. *Sporangia* globose, borne on the club-shaped ramelli.

The frond in this genus consists of two distinct and separately organised systems—one mineral, and which wholly disappears when the plant is put into muriatic acid ; the other vegetable, of the same texture, substance, and very similar organization to the frond of the following genus (*Dasycladus*) ; but still more nearly akin to another genus, *Neomeris*, not yet recorded from our shores, but which very probably exists on the Florida reefs, as one of its species is found in the West Indies. For sake of greater clearness, I have, in the above diagnosis, first described the outer crust, or frond, as it appears when lifted from the sea ; and then given the characteristics of the vegetable axis which is brought to light when the calcareous envelope has been removed by acid. When the plant is alive, and seen under water, its green colour, and the rich pencils of delicate, bright green byssoid fibres that crown all the growing branches and their divisions, at once suggest its vegetable nature. But when seen dry and dead on the shore, where all these fibres and the green colour disappear, the resemblance to a porous zoophyte is so great, that it is no wonder that this Alga should, until quite recently, have had a place in the animal kingdom. The pores of the crust may easily pass for polype cells, and the enclosed tube has, when dry, an almost horny consistence.

Two species, *C. barbata* and *C. rosarium* are usually kept up, and Kützinger has added a third, *C. bibarbata*, but it seems to me that the differences indicated have reference more to the age and state of individual specimens, than to difference of species. The fringing or non-fringing of the apices with fibrillæ surely depends on the state of the specimen. The fibrills are homologues of leaves, and, like leaves, are deciduous when they have performed their functions. I had abundant opportunities of studying the species at Key West, and see no ground for believing that there is more than one as yet known to botanists.

1. *CYMOPOLIA barbata*, Lamour. *Cor. Flex.* p. 293, and *C. rosarium*, *l. c.* p. 294. Kütz., *Sp. Alg.* p. 511. *Corallina barbata*, *Lin. Syst. Nat. Ed.* 12, p. 1305. *Ellis and Sol. Zoop.* p. 112. *Ellis, Cor.* p. 54, t. 25, f. C. *C. rosarium*, *Ellis and Sol. Zoop.* p. 111, t. 21, fig. h. *Sloane, Nat. Hist. Jamaica*, t. 20, fig. 3. *Cymopolia bibarbata*, Kütz. *Phyc. Gen.* t. 40, f. 2. Kütz. *Sp. Alg.* p. 510. (TAB. XLI. A.)

HAB. Near low-water mark, under the bridge at Key West. *W. H. H.* (v. v.)

*Fronde*s tufted, at first simple, till they attain to one or two inches in height, then becoming branched, at first by the development of simple alternate branches. These afterwards fork at their extremities, and throw out lateral branches; and by continual repetitions of this process of division the frond at length becomes much branched in a di-trichotomous but irregular order. The tendency to become dichotomous is greater in the older specimens; the branches in all are fastigiate. Every part of the frond, except the young tips of the branches, is invested with a thick calcareous, brittle crust, pierced with innumerable horizontal canals, opening at the surface by pores, arranged in transverse rings, which are so closely placed together that the surface appears as if honeycombed. In these canals of the crust the ramelli of the enclosed vegetable lie hid, the points only of their divisions protruding through the pores, and this only in the younger parts, which then have a green colour. The calcareous crust is regularly articulated at short intervals; the internodes in the main stem and branches are about twice as long as broad, those in the young parts of the frond spheroidal and bead-like. The *nodes* are much contracted throughout, and thus each branch looks like a string of beads. In the older parts the nodes are bare; but in the younger, toward the ends of the growing branches, they emit whorls of extremely delicate, byssoid, di-tri-chotomous or multifid, membranaceous fibrills; and whorls of similar fibrills terminate the young branch itself. The branches in the developing plant are thus penicillate or barbed at the extremity. When a piece of a frond is macerated in acid, so as to remove the calcareous crust, the true frond becomes visible. This we must now describe. It consists of a continuous, tubular axis or filament, seemingly formed of a single, cylindrical, branching cell, which runs through every part of the calcareous covering, and whose growing apices, clothed with byssoid fibres, protrude at the ends of the branches. This filament is nodose, annularly constricted at short intervals, corresponding to the articulations of the crust; but there are no inter-

nal septa. The wall is very thick and tough, and is evidently seen, under the microscope, to be formed of concentric layers, deposited one within another, as in the cell-wall of the *Caulerpæ*. When a transverse section of a branch is examined, the ring of cell-wall appears as if divided into numerous cells, corresponding in number to the ramelli that issue from it; the apparent septa of these supposed cells being placed opposite the insertion of the ramelli. This would suggest a structure not very different from what I have just described; namely, that the axial tube was not a single cell, but a tube formed by the lateral cohesion of a number of small, cylindrical, longitudinal cells, placed in a circle; a structure not very different from what occurs in *Batrachospermum*. After repeated examinations and dissections I am disposed to think that the appearance of cell-division in the wall is deceptive, and that what look like septa are prolongations inwards, through the wall, of the bases of the ramelli. The internodes of the axial filament are beset with very closely placed whorls of horizontal ramelli, each composed of a primary, and 3 or 4 secondary, clavate cells; the primary cell issuing from the substance of the wall of the axial tube, and forming the basal portion of the ramellus; the secondary cells springing from its apex. The primary cell is obconical; the secondary more clavate, and inflated at the point. *Fructification* takes place by the transformation of one of the secondary or terminal cells of the ramellus, which is changed into a spherical *sporangium*, filled (at first) with dense, dark green granular matter, surrounded by a pellucid margin, and raised on a short stalk. Whether it eventually contains *spores* or only *zoospores*, I have not determined; analogy with *Dasycladus* would lead us to the former inference. The colour of the frond, when growing, is a pleasant, and rather a full, yellow green; when dry, the calcareous crust fades to a dirty white, and the tufts of byssoid apical fibrills become brown or black, staining the paper to which they adhere.

Ellis's figures, quoted above, are both characteristic; and so also is that in Sloane's Jamaica, though rude and without analysis. Lamouroux strangely misquotes, under his *C. rosarium*, Sloane, Tab. 20, fig. 4, which is a very fair representation, not of a *Cymopolia*, but of *Amphiroa fragilissima*.

PLATE XLI. A. *Fig* 1. *CYMOPHOLIA barbata*; the *natural* size. *Fig* 2. Apex of a branch, crowned with its pencil of byssoid fibres. *Fig* 3. Transverse section of a branch, from which the calcareous shell has been removed. *Fig* 4. Small portion of the same, showing a *sporangium* formed from one of the peripheric ramelli. *Fig* 5. Portion of a longitudinal section of a branch, to show the insertion of the horizontal ramelli, and the holes on the inner face of the cell wall. *Fig* 6. Byssoid fibres from the apical pencil. *Fig* 7. Tips of the same; the latter figures more or less highly *magnified*.

II. DASYCLADUS. *Ag.*

Fronde destitute of calcareous crust, soft, and flaccid, cylindrical or club-shaped, unbranched, composed of a tubular, unicellular filiform axis, beset throughout with closely placed whorls of trichotomous, horizontal, articulate ramelli. *Sporangia* globose, affixed to the nodes of the ramelli, and containing, at maturity, very numerous spherical spores.

Small, densely tufted, erect plants, with almost spongy fronds, so densely are the ramelli frequently inserted. Their substance is very soft and flaccid, but tough, and the colour a full dark green. The membrane composing the frond is every where hyaline, and becomes glassy when dry; the colouring matter is viscid and granular as in *Bryopsis*. The genus was founded by Agardh on *D. clavæformis*, a common Alga in the Mediterranean; and Meneghini has described a second species from the Adriatic. I now venture to add a third, which I was formerly disposed to consider as identical with *D. clavæformis*.

1. *DASYCLADUS occidentalis*; whorls sub-distant; apices of the ramelli very obtuse. (TAB. XLI. B.)

HAB. On rocks between tide marks, on the Florida Keys. Key West, *Dr. Wurde-mann*, *W. H. H.* Key Biscayne, *Prof. Tuomey*. (v. v.)

Root discoid, throwing out a few clasping fibres. *Fronds* mostly densely tufted, sometimes solitary, 1–2 inches high, clavate, from a line to nearly half-an-inch in diameter (including ramelli) erect, straight or curved, destitute of calcareous incrustation; consisting of a filiform, unbranched, unicellular axis, whorled throughout with densely inserted polychotomous ramelli. The axial filament varies in diameter from the thickness of a human hair to twice the diameter of hog's bristle; it is cylindrical, with a continuous cavity filled with endochrome, and seems to be developed from a single cell. Its wall is very thick, tough, and composed of several distinct layers of cellulose, concentrically deposited. The filament is marked externally, at short intervals, varying in distance in different specimens, with transverse rings or *nodes*, which give an appearance of joints (but there are no internal septa); and immediately above each node from six to twelve horizontal ramelli are inserted in a whorl, and in denuded specimens their places are indicated by a whorl of disc-like scars surmounting the node. The ramelli vary much in length and in density. In some specimens the internodes are so short that the frond seems continuously clothed, like the spongy frond of a *Codium*, from base to apex; the axis being completely concealed by the ramelli. In others the internodes are as much as a line in length, and the whorls appear sub-distant, like those of a *Myriophyllum*. Sometimes the ramelli are scarcely a line long; in other specimens they are 2–3 lines or more. In all cases they are tri-dichotomous, twice or

thrice compounded and articulated ; being formed of two or three series of nearly cylindrical cells, four to six times longer than broad, filled with dark green slimy endochrome. The terminal cells are very obtuse. *Fructification* is formed at the axils of the ramelli, where two or three supplementary cells are developed and become spherical *sporangia*, by absorbing all the endochrome of the cells from which they spring, and finally that of the whole frond. When ripe, these sporangia are membranous bags, stuffed with innumerable spherical spores. *Colour*, a deep grass-green. *Substance*, soft and somewhat gelatinous.

This species closely resembles, in habit and structure, *D. clavæformis* of the Mediterranean ; but the ramelli, even in the densest specimens, are much more distantly placed than in that plant, and the apices (or terminal cells) of all the American individuals I have examined are perfectly blunt ; not mucronulate, as they are in *D. clavæformis*. If this distinction prove constant, the species will be sufficiently characterised.

PLATE XLI. B. *Fig. 1.* *DASYCLADUS occidentalis* ; the normal form. *Fig. 2.* An attenuated and depauperated variety ; both figures the *natural* size. *Fig. 3.* Transverse section of the frond, showing a whorl of trichotomous ramelli. *Fig. 4.* Portion of a fertile ramellus with *sporangia*. *Fig. 5.* A *sporangium*. *Fig. 6.* *Spores* from the same ; all the latter figures *magnified*.

III. ACETABULARIA. *Lamour.*

Root scutate. *Frond* stipitate, umbrella-shaped, thinly incrustated with calcareous matter. *Stipes* tubular, unicellular, cylindrical, when young emitting whorls of byssoïd fibrills at and below the summit ; when mature, crowned with a peltate disc, formed of numerous radiating cuneiform cells. Cells of the disc at first containing granular endochrome, which is afterwards changed into spherical spores.

The two species which are included in this genus are among the most elegant and singular of the Algæ, resembling delicate fungi of the genus *Agaricus*, more nearly than any marine production. This is, however, descriptive only of the fully grown plant, for in the young state, the peltate umbrella which crowns the stipes is not found. In the youngest specimens which I have examined (represented at fig. 2 in our plate) the upper part of the stipe is beset at sub-distant intervals with whorls of extremely slender byssoïd fibrills, above the last of which a young disc is commencing to be formed. In older plants these fibrills drop away, and their position is indicated by an annular row of holes, the tube being also swollen at each whorl, so as to appear jointed. There are no septa, however, and the tube is continuous, at least to the base of the young disc. When the disc is further advanced, a dense pencil of fibres springs from its centre, on its upper surface, or from what may be called its *umbo*, and which is

really the growing point of the frond. I regard the disc as being properly a whorl of *sporangia*, united by their edges ; each radiating cell constituting a sporangium. The discs, after they have developed spores, are deciduous ; and new ones are successively formed, one above the other, as the stipe lengthens.

1. *ACETABULARIA crenulata*, Lamour. ; margin of the peltate disc minutely crenulate ; the cells apiculate (when young). *Lam. Pol. Flex. p. 6, Tab. 8, fig. 1.* Kütz., *Sp. Alg. p. 510.* (TAB. XLII. A.)

HAB. Rocks and corals, within tide marks, on the Florida reefs. Key West, *W.H.H.*, *Prof. Tuomey* (v. v.)

Root minute, discoid. *Fronds* scattered or tufted, two or three inches high, consisting of a slender, setaceous stipes, thinly coated with carbonate of lime, and bearing at its summit a peltate disc or cup, radiated like an agaric, and formed of clavato-cylindrical cells cohering by their edges, and filled with green endochrome. The stipes, when deprived of its lime by maceration in acid, forms a membranous, cylindrical tube, destitute of markings, slightly enlarged upwards, having near its summit one, two, three, or more (according to age) annular swellings, from which issue whorls of very delicate, polychotomous, byssoid ramelli, and terminating in the first formed disc, from whose centre a pencil of similar byssoid fibres is produced. In further growth, the stipes proceeds through the first disc upwards for a distance of 1–2 lines, where another annulus emits a second whorl of filaments, above which a second disc is formed ; and thus, by successive apical growths new discs succeed each other, the older falling off as the younger are formed. In old specimens, therefore, you find the upper part of the stipe furnished with 4–5 or more annuli, marked with scars of the fallen ramelli and discs. In full grown specimens, the peltate disc, or circle of sporangia, is nearly half-an-inch in diameter. At first the matter contained in its cells is fluid and homogeneous. Eventually nuclei are formed in it, and the contents of each cell is converted into numerous globose spores, the whole endochrome being consumed in the process. The cell-wall of the stipe is thick and concentrically striate.

This species very closely resembles *A. Mediterranea*, from which it is distinguished by the minutely crenulate margin of the disc. In *A. Mediterranea* the margin is quite entire.

Plate XLII. A. *Fig. 1.* *ACETABULARIA crenulata* ; the natural size. *Fig. 2.* Apex of a young frond, before the development of the peltate disc. *Fig. 3.* A young disc, within which is a pencil of byssoid fibres. *Fig. 4.* A mature disc. *Fig. 5.* Apex of one of the radiant cells, from a young disc in which they are mucronate. *Fig. 6.* One of the radiant cells of a mature disc, converted into a *sporangium*, and full of spores. *Fig. 7.* Spores from the same : all the latter figures magnified.

ORDER III.—VALONIACEÆ.

Valoniæ, in part, Kütz. *Sp. Alg.* p. 507. *Anadyomenæ*, *Dictyospheriæ*, and part of *Codiæ*, Kütz. l. c. *Siphonæ*, in part, Auct. alior.

DIAGNOSIS. Green marine Algæ, naked or encrusted with carbonate of lime, with fibrous roots. *Fronde* polymorphous, formed of large vesicated cells filled with watery endochrome; either consisting of a single cell, or of several united into filaments, or into net-works or membranous leaf-like expansions.

NATURAL CHARACTER. *Root* in most cases well developed, and consisting of a plexus of tough fibres, forming a mat, and either penetrating the sand or grasping firmly to the rock or stones on which the plant grows. *Fronde* very variable in form, and in complexity of structure. In *Valonia* the whole frond, in some species, consists of a single vesicated cell, which is often of large size, upwards of an inch in length, and three-quarters of an inch in diameter, filled with a thin, watery endochrome. In other species of that genus, several such cells are strung together so as to form confervoid branching filaments. In *Dictyosphaeria*, a number of large globose cells cohere together in a single stratum, and thus form a tessellated or honey-combed membrane. In *Anadyomene*, the membranous expansion is formed in a different manner, namely, by the lateral cohesion and anastomosis of a branching filament; and in *Microdictyon*, a network is formed in a similar way, the difference from *Anadyomene* being, that the branches of the generating filament stand apart, leaving open spaces between their anastomosing ramuli. A further advance in structure occurs in *Penicillus*, where the frond has a dendroid habit; the trunk of the treelike body being composed of branching, unicellular filaments like those of a *Codium*, and the head of confervoid, articulated filaments like those of *Valonia*. This spongy caudex, or trunk, appears to me to be merely an exaggeration of the rooting processes, common to most plants of the family. A more definite stipes, or true stem, is found in *Chamædoris*, *Apjohnia*, and *Struvea*, the most highly organised genera of the Order, and those which connect it with the *Dasycladæ*. In these the stipe is monosiphonous, and is developed nearly to its full size before any part of the capitulum makes its appearance. In the early stage these plants are not to be known from the simple *Valoniæ*, and like them consist of a single cell rising from a branching root.

In this description of the fronds of the Order I omit the curious plant which will be

found described below under the name *Blodgettia*, because it is not quite certain whether it be properly a member of this series ; or possibly the type of a separate family.

The fructification of none of these plants is satisfactorily known.

All are natives of tropical and sub-tropical latitudes. The Penicilli or *Merman's Shaving Brushes* are characteristic of coral reefs, and are found in the Caribbean Sea, and on the shores of Australia and of the Indian archipelago. *Anadyomene* is common to the Mediterranean Sea, the Gulf of Mexico and the shores of Brazil. *Dictyosphæria* is tropical and Australian. *Valonia* is found in most western oceans, and ought to occur on the Floridan Keys, though not yet found there. *Microdictyon* is generally a deep water production, lying at the bottom in 5-10 fathoms ; but it sometimes occurs at low water mark. Species of it, all very similar to each other, have been found in the tropics of both hemispheres and in the Mediterranean ; and one is very abundant in Port Jackson, Australia. *Struvea* is confined to the West coast of Australia, and *Apjohnia* to the Southern coast. *Chamædoris* is Caribbean ; and *Acrocladus*, Næg., a closely allied form, is found in the Mediterranean.

TABLE OF THE NORTH AMERICAN GENERA.

* *Dendroid ; stipitate, crowned with tufted filaments.*

I. CHAMÆDORIS. *Stipes monosiphonous, annulated ; head very dense.*

II. PENICILLUS. *Stipes formed of innumerable interwoven filaments, spongy ; head brush-like.*

** *Confervoid ; densely tufted.*

III. BLODGETTIA. *Fronde filamentous, articulated, branching, densely tufted.*

*** *Membranous, leaf-like.*

IV. ANADYOMENE. *Membrane erect, flabellately veined ; veins articulated, confervoid, radiating from the base toward the margin.*

V. DICTYOSPHERIA. *Membrane amorphous, wholly formed of spherical cells lying in a single stratum.*

I. CHAMÆDORIS, Mont.

Root much branched. *Fronde* stipitate, dendroid. *Stipes* at first clavate, then cylindrical ; tubular, unicellular, horny-membranous, annularly constricted and corrugated, at length crowned with a dense fascicle of confervoid, much branched, articulate ramelli. *Fruit* unknown.

Young and full grown specimens of the little Alga which constitutes the present genus are so unlike that they might readily pass for different entities. The frond originates in a dense mass of branching, horny-membranous, intricate, rooting fibres, from which spring erect unicellular branches, or fronds. These are at first quite simple and naked; but afterwards develope from their summit two or three very closely placed whorls of much branched ramelli, which form a dense, fasciculate capitulum. The frond is then mature and resembles a little tree; or perhaps, more justly, a little mop. The genus was founded by Montagne in 1842, by a separation from *Penicillus*.

1. *CHAMÆDORIS annulata*, Mont. *An. Sc. Nat. Ser. 2, vol. 18, p. 261.* *Kütz. Sp. Alg. p. 509.* *Nesæa annulata*, Lamour. *Pol. Flex. p. 256.* *Corallina peniculum*, Ell. and Sol. *Zoop. p. 127, tab. 7, fig. 5-8 and tab. 25, fig. 1.* (TAB. XLII. B.)

HAB. Key West, rare. *W. H. H., Dr. Blodgett. (v. v.)*

Root composed of many branching and clasping, tufted fibres, which issue from the base and lower part of the stipes, and at length form a dense mat. *Fronde*s tufted, 2-3 inches high, nearly a line in diameter, tubular, simple, membranaceous or somewhat horny, destitute of calcareous incrustation except in old age, when they are thinly coated toward the base; cylindrical, annularly constricted at short intervals as if jointed, the internodes most apparent on old specimens, when the annular constrictions are deeper. In the young state the frond consists merely of such an annulated tube, formed of a single cell. When this has attained the height of two or three inches, it ceases to grow longer; a septum is formed just below the summit, and a new cell begins there to develope. This second cell is very short, and again divides, once or twice, vertically; so that the original tubular cell (now to be called the *stipe*) is crowned with two or three minute cells, placed one above the other (TAB. XLII. *fig. 3*), the terminal one being attenuated and pointed. These cells remain short and rudimentary, but from their nodes dense whorls of *ramelli* begin to grow (*fig. 4*), which finally constitute a dense, mop-like capitulum. When fully grown the capitulum is an inch or more in diameter, globose, very dense, composed of innumerable, crowded and interwoven, much branched, irregularly dichotomous, articulated filaments. The articulations are cylindrical, constricted at the nodes and many times longer than broad; but variable in length. *Colour*, a bright, grass-green. *Substance*, membranaceous, rather rigid and tough, not adhering to paper in drying. Thin slices of the tube, when examined under the microscope, show concentric lines of growth, as in *Dasycladus*, &c.

This plant is rare at Key West, and none of my specimens are fully grown. It is a native of the West Indian Islands.

PLATE XLII. B. *Fig. 1.* *CHAMÆDORIS annulata*, the natural size. *Fig. 2.* A young, unicellular frond, previous to the formation of the capitulum. *Fig. 3.* Apex of a frond in a more advanced stage, showing the newly formed axial cells of the future capitulum. *Fig. 4.* Apex of a still more advanced young frond, with the capitulum beginning to be

formed. *Fig. 5.* Portion of the capitular filament; the latter figures more or less magnified.

II. PENICILLUS. *Lamarck.*

Root fibrous, much branched, matted. *Frond* stipitate, dendroid. *Stipes* erect, cylindrical or compressed, incrustated, wholly composed of numerous longitudinal, unicellular branching filaments woven together into a compact spongy mass; and crowned with a dense pencil of confervoid, articulate ramelli, whose branches are either free, or cohere together in fan-shaped laminæ, and are invested with a porous pellicle of carbonate of lime.

If Mer-men have beards and shave them, the Algæ included in this genus may serve as shaving brushes. The *root* is much branched and its fibres matted together, and generally penetrates deeply into the sand in which the plant grows. The *stipe* is more or less coated with carbonate of lime, and composed of a multitude of closely placed and densely interwoven longitudinal, unicellular filaments, which send off laterally, throughout their length, short, fastigate, corymbose ramelli, that unite together to form a periphery. Thus far we have a structure closely agreeing with that of a *Codium*. But from the apex of this compact, spongy stipe there springs a dense tuft or capitulum, composed of dichotomous, articulated, free filaments; and the whole frond bears a striking resemblance to a shaving brush. The habit is similar to that of *Chamædoris*, from which the spongy, multicellular stipe distinguishes it; and to *Chlorodesmis*, which differs in having a capitulum formed of unicellular filaments.

The species naturally arrange themselves in two groups, or sub-genera, which Kützinger has separated; a separation which is hardly needed, where the species are so few in number and so closely related in structure.

Sect. 1. HALIGRAPHIUM, Endl. (*Corallocephalus*, Kütz.); branches of the capitulum free.

1. PENICILLUS *dumetosus*, Dne.; stipes short, thick, somewhat compressed, velvety; filaments of the capitulum loosely spreading, ultra-setaceous, flaccid, deep-green; their joints cylindrical, many times as long as broad, equal, obtuse, strongly constricted at the nodes. *Dne. Cor. p. 97.* *Nesæa dumetosa*, Lamour. *Polyp. p. 259. pl. 8, fig. 3, a. B.* *Corallocephalus dumetosus*, Kütz. *Sp. Alg. p. 506.* (Tab. XLIII. A.)

HAB. Key West and Sand Key, *W.H.H.* Soldier's Key, *Prof. Tuomey.* (v. v.)

Root, a dense mass of fibres deeply sinking in the sand. *Stipes*, 1–3 inches long, half-inch to nearly an inch in thickness, sometimes rather hollow in the centre, more or

less compressed, erect, coated with a velvety scurf, and partially incrustated with calcareous matter ; nearly destitute of lime when young, much incrustated with it in old age. This stipes is composed of innumerable, densely packed, longitudinal, unicellular fibres which closely adhere by lateral branching processes, and are interlaced together. The outer strata of these fibres emit, to form the periphery of the stipe, innumerable short, lateral, horizontal, multifid, fastigate ramelli, whose apices, lying close together, give the velvety appearance to the surface. As long as these longitudinal filaments cohere into a stipe they are unicellular ; but when they become free at the apex of the stipe, they are articulated, or pluricellular ; and a capitulum of confervoid filaments completes the frond. According to the age of the specimen, the filaments of the capitulum are more or less developed ; in young specimens they are less than an inch long ; in older and full-grown ones they vary from 3 to 6 inches. They are densely, but not intricately tufted, thicker than hog's bristle, dichotomous, radiating to all sides, equal and obtuse ; their articulations are cylindrical, and many times longer than broad. The colour is a full, deep green, and they are very thinly incrustated with lime ; the crust pierced with minute pores. The primordial utricle separates readily from the cell-wall, and is firmly membranous.

PLATE XLIII. A. *Fig. 1, 2, 3.* *PENICILLUS dumetosus*, of different ages : the natural sizes. *Fig. 4.* Portion of one of the dichotomous filaments of the capitulum. *Fig. 5.* Small portions of the same, after the calcareous coating has been removed, showing a pitted surface ; the latter figures more or less *highly magnified*.

2. *PENICILLUS capitatus*, Lamk. ; stipes long or short, cylindrical or clavate, terete, incrustated, smooth ; filaments of the globose capitulum densely crowded, fastigate, capillary, rigid, pale green, their joints cylindrical, many times as long as broad, obtuse, constricted at the nodes. *Dne. Cor. p. 97.* *Nesæa Penicillus*, *Lamour. Pol. flex. p. 258.* *Corallina Penicillus*, *Ell. and Sol. p. 126, tab. 25, fig. 4, 5.* *Corallocephalus Penicillus*, *Kütz. Sp. Alg. p. 505.* (TAB. XLIII. B.)

HAB. Key West, *W. H. H., Prof. Tuomey.* (v. v.)

Root very large, two inches long or more, deeply descending, very fibrous and densely matted. *Stipes* from one to four or five inches long, a quarter to a third of an inch in diameter, mostly cylindrical and equal throughout, occasionally compressed and widened upwards, thickly incrustated with calcareous matter, and having a smooth and sometimes a polished surface. *Capitulum* very dense, mostly globose, sometimes oblong and rarely somewhat diffuse, fastigate, one or two inches in diameter, composed of innumerable, curved, densely packed and often entangled, capillary filaments which are encrustated with calcareous matter to an extent that makes them rigid. The structure is similar to that of the preceding species ; and the calcareous incrustation is similarly dotted or pitted. The length of the articulations varies much ; usually

they are many times as long as broad ; but now and then a short, globose articulus is interposed between the two long ones. *Colour*, a pale green.

PLATE XLIII. B. *Figs. 1, 2, 3. PENICILLUS capitatus*, different varieties ; the *natural* size. *Fig. 4.* Portion of a dichotomous filament from the capitulum. *Fig. 5.* Small portion of the same, after the lime has been removed ; the latter figures more or less highly *magnified*.

Sect. 2. HALIPSYGMA, Endl. (*Rhipocephalus*, Kütz.) ; branches of the capitulum cohering in flabelliform laminæ.

3. *PENICILLUS Phoenix*, Lamk. ; stipes elongate, terete, incrusted, smooth ; capitulum ovoid or oblong, its filaments incrusted, very slender, dichotomous, cohering by their edges into many distinct, flat, cuneate, level-topped, spreading laminæ. *Dne. Cor. p. 98. Lamk. An. Mus. 20, p. 299. Corallina Phoenix, Ell. and Sol. p. 126, t. 25, fig. 2-3. Nescæa Phoenix, Lamour, l. c. p. 256. Rhipocephalus Phoenix, Kütz. Sp. Alg. p. 506. (TAB. XLIII. C.)*

HAB. Key West, W. H. H. Dredged in $3\frac{1}{2}$ fathoms off Soldier's Key, *Prof. Tuomey.* (v. v.)

Root somewhat fusiform, dense, descending. *Stipes* cylindrical, 1-3 inches long, a quarter inch in diameter, thickly incrusted with calcareous matter, the surface smooth, composed as in the rest of the genus of many slender longitudinal branching and ramelliferous threads. The filaments of the capitulum are thickly incrusted with calcareous matter, and disposed in many flat, cuneate, flabelliform laminæ ; their ramifications lying close together, and cohering laterally by means of the incrustation. On removing the carbonate of lime the cohesion of the filaments is destroyed. The articulations are many times longer than broad, cylindrical, and much constricted at the nodes.

PLATE XLIII. C. *Fig. 1. PENICILLUS Phoenix*, the *natural* size. *Fig. 2.* Portion of one of the fanlike laminæ of the capitulum. *Fig. 3.* Cells from the same, after the removal of the lime ; the latter figures more or less *magnified*.

III. BLODGETTIA, Harv. (*n. gen.*)

Fronde cæspitose, branching, confervoid, articulate. *Articulations* unicellular, filled with grumous, viscid endochrome ; the cell-wall formed of separable membranes,

the outer of which are hyaline and homogeneous, the innermost traversed by parallel, longitudinal, anastomosing veinlets. *Spores* seriated in moniliform strings, and developed from the veinlets of the inner cell-wall (!)

The highly curious little Alga on which the present genus is founded so closely resembles a *Cladophora* that it will readily pass for one, unless it be very closely examined under a powerful microscope. Indeed so great is the resemblance to a branched *Conferva* that I formerly distributed it to my friends with the manuscript name of *Cladophora cæspitosa*, under which it was my intention to have described it in the present work ; nor did I discover my error until I commenced making sketches for the plate now given. I was then first struck by the peculiar opacity of the dissepiments ; and afterwards by what looked like a compound cellular structure in the walls of the cells. On applying a higher power, other characters came out which induced me to dissect one of the articulations, when I discovered the curious structure of the inner membrane or primordial utricle ; in which (as far as I can make out) the spores are developed. To see the structure, as above described, the readiest mode is to proceed as follows. Cut off a portion of one of the long cells which terminate the branches ; place it on the table of a dissecting microscope, moisten it, and you may readily express the viscid endochrome, which generally contains, besides the usual starch and chlorophyll grains, a number of pyramidal crystals ; but these are probably adventitious. When the endochrome has been pressed out, the structure of the inner membrane of the cell-wall may be partially seen ; but to see it clearly, the outer coats must be removed. This may readily be done, either by tearing, with a pair of dissecting needles, or by making a longitudinal section through the cell, when the different coats easily separate, on the section being *teased* in a drop of water. The outer coat, or coats (for there are *two* or more, though the secondary ones sometimes elude detection, owing to their extreme tenuity) are quite transparent and structureless, as is usually the case in the walls of cellular tissue. But the inner coat offers a peculiarity of structure which I have not noticed in any other Algæ, nor have heard of its occurrence in the cells of any other plant. At first sight the membrane seems to be composed of numerous minute, elongated fusiform cellules, not unlike the wood-cells of phanerogamous plants, but totally unlike any algæ-cells known to me. Careful examination has however convinced me that the appearance of cellular structure is deceptive ; and that the membrane itself is homogenous, but traversed by slender filaments or nerves, which anastomose together, forming areolæ which look like cells. These filaments give off *free* ramuli whose apices swell into spores ; and (probably) by repeated cell division produce the strings of roundish *spores*, which are so conspicuous in most of the areolæ. The appearance of the whole membrane with its spores is as if a number of the *asci* of a lichen were placed side by side ; the true structure, however, I need hardly say, is widely different.

The generic name is bestowed as a grateful tribute to the memory of the late DR. BLODGETT of Key West, who had zealously collected and studied the Algæ of the reefs where this plant grows, and to whom I am indebted for many specimens of the rarest Algæ of the Florida Keys.

1. *BLODGETTIA confervoides*, Harv. (TAB. XLV. C.)

HAB. At Key West, on rocks near low-water mark. *Dr. Wurdeman, W. H. H., Prof. Tuomey.* (v. v.)

Fronds filamentous, densely tufted ; the tufts spreading extensively, from an inch to an inch and half in height, very dense, pulvinate and fastigiate. *Filaments* rigid, not collapsing when removed from the water, about as thick as hog's bristle, sparingly branched, decumbent at base, then ascending, and the tips erect. The main divisions and primary branches are very patent, either arching backwards or quite recurved. They are destitute of branches along their lower or outer side, and more or less furnished with unilateral ramification on the upper ; generally with a long excurrent point destitute of ramuli. Often the filament has but a single series of simple, secund ramuli ; but in luxuriant specimens there is a second series of similar secund ramuli. *Articulations* variable in length, dark coloured, with opaque dissepiments, and not collapsing when dry, contracted at the nodes, three to six times as long as broad ; the terminal cell always very much longer than the rest, and frequently 10–12 times as long as its diameter. *Apices* very blunt. The articulations are filled with dense, viscid endochrome full of large green granules, and frequently containing also prismatical crystals. The membranous cell-wall is divisible into three or more separate membranes, one concentrically placed within the other. The outer are hyaline without obvious structure ; but the inner one is reticulated with very slender nerverlike fibres, which run longitudinally through the membrane parallel to each other, and are connected by oblique crossbars ; so that the surface is divided into narrow, pointed areolæ. The *spores* are seriated in moniliform strings, four or more in each string, and attached to short free veinlets which issue from the veins of the inner cell-wall. The *colour* when recent is a very dark green ; when dry it becomes more olivaceous. The substance is very firm, and the plant imperfectly adheres to paper in drying.

PLATE XLV. C. *Fig. 1.* *BLODGETTIA confervoides* ; the natural size. *Fig. 2.* Pectinated branch. *Fig. 3.* Apex of the long terminal cell of the branch, the lower portion represented with the outer cell-coats exfoliated. *Fig. 4.* Portion of the membrane of the innermost cell-coat traversed by slender fibres, bearing strings of *spores* (?). *Fig. 5.* One of the moniliform strings, apart. *Fig. 6.* Some of the crystals found in the cells. All the latter figures more or less highly magnified.

IV. ANADYOMENE, *Lamour.*

Root fibrous. *Frond* stipitate, membranaceous, leaf-like, flabellately veined ; the veins confervoid, radiating from the base to the margin, pedately multifid, excessively branched, and everywhere closely anastomosing. *Fructification* unknown.

The frond in this genus is thin and membranous, and at first view resembles that of an *Ulva*, except that it is traversed everywhere by branching veins. When more closely examined it is easily perceived that the membrane is wholly formed by the anastomosis and lateral cohesion of the branches and ramuli of a much branched, articulated, confervoid filament, composed of large, oblong cylindrical cells ; as more fully detailed in the subjoined description. As Professor J. Agardh remarks (*Alg. Medit.* p. 24), it is nearly related to *Valonia*, from which it differs chiefly in the lateral cohesion of the branches of the generating filaments, and to which it bears the same relation that *Codium* does to *Vaucheria*. It is still more nearly related to *Microdictyon*, where the fronds form an open network.

1. *ANADYOMENE flabellata*, Lamour. ; frond flattish or undulate, the veins multipartite. *Lamour. Pol. Flex.* p. 365, *tab.* 14, *fig.* 3. *Bory, Fl. Mor. t.* 41, *fig.* 5, *Kütz. Sp. Alg.* p. 511. *A. stellata*, *Ag. Sp. Alg.* 1, p. 400. (TAB. XLIV. A.)

HAB. Key West, on tidal rocks, common. *Dr. Wurdeman, W.H.H., Prof. Tuomey.* (v. v.)

Root consisting of a mat of branching, articulate, confervoid filaments, emitting erect branches which develope into flat, flabelliform, membranous fronds. *Fronds* tufted, 1-4 inches long and as much in width, rigidly membranaceous, shortly stipitate ; the stipes uni- or pluri-cellular ; lamina at first flabelliform and entire, afterwards undulate and more or less deeply lobed at the margin ; wholly composed of radiating, multifid, branching, confervoid filaments, whose distichous branches closely cohere throughout, and whose ramuli as constantly anastomose and coalesce. In other words, the membrane is composed of longitudinally seriated, cylindrical cells, several series radiating from the base toward the circumference in a flabellate manner, and dividing and subdividing digitately throughout the whole length of the series ; each cell emitting from its summit 5-7 or more similar cells, which in their turn put forth another series, and so on. In this way the frond increases in length. It is widened by the gradual evolution of other cells formed along the sides of contiguous parallel cells in a pinnate order. At first these lateral or transverse cells are very minute and placed opposite each other. They gradually lengthen, anastomose and coalesce, and at length form a reticulated space of a narrow wedge-form between each pair of tubular, longitudinal cells. The cuneate space looks like a membrane, but is really constituted of closely placed, transverse bars, leaving narrow slits between them, as may be readily seen by examining a dried specimen when the substance shrinks. In a moist state, by the swelling of the cells, the slits close up, and the frond appears as if continuously membranous. The tubular, longitudinally seriated cells, or those that form the veins and nerves of the frond, seem to continue to lengthen during the whole growth of the lamina ; they are short in young plants, longer in others, and in old plants are many times longer than their diameter. The cell-wall in these cells is thick and tough, and when viewed under a

moderately high magnifying power it appears to be transversely striate. The primordial sac readily separates from the outer cell-wall.

This plant was first noticed in the Mediterranean Sea, where it grows in the fissures of littoral rocks in many places. It occurs also in Brazil, from whence I possess a specimen; and is found generally throughout the West Indian Islands. Our Key West specimens are rarely more than two inches high and about three in breadth. The largest specimen I possess was given me by the late Mr. Menzies, as having been dredged in twenty fathoms in the Gulf of Mexico. This specimen measures six inches across, and its venation offers some peculiarities; which perhaps may lead to its specific separation. In our Key West plants the seriated cells of the principal veins stand apart from each other, or are in single file, leaving wedgeshaped spaces between. In Mr. Menzies' specimen the principal veins are partly unicellular, partly formed of several parallel, closely placed cells, without interspaces. The structure is easily seen, but difficult to describe in intelligible language. Should subsequent observations establish this plant as a species, it may be called *A. Menziesii*.

PLATE XLIV. A. *Fig. 1.* *ANADYOMENE flabellata*, full grown; and *Fig. 2*, a young plant; the *natural* size. *Fig. 3* represents *Fig. 2*, *magnified*, to show the structure of the frond.

V. DICTYOSPHERIA. *Dne.*

Root consisting of a few grasping processes. *Frond*, a decumbent, amorphous membrane composed of a single series of vesicated, sub-globose, tough-coated cells, filled with green, fluid endochrome. *Fructification* unknown.

The plant for which this genus was defined by Decaisne was formerly referred to *Valonia*, to which no doubt it is closely allied, but from which it differs by the greater lateral coherence of the cells which compose the frond, and also by the structure of these cells. It is of common occurrence throughout the tropics of both hemispheres. On the coast of Australia a second species is equally common, differing from *D. favulosa* in the frond being never vesicated, and in the component cells being very much smaller, the surface flatter, and the frond having a silky lustre. This I have elsewhere described under the name *D. sericea*.

1. *DICTYOSPHERIA favulosa*, *Dne.*; frond at first globose and hollow, afterwards irregularly torn, expanded; the vesicated cells globoso-hexagonal, convex, and very prominent. *Dne. An. Sc. Nat. Ser. 2. vol. 17, p. 328. Kütz. Sp. Alg. p. 512. Valonia favulosa, Ag. Sp. Alg. 1. p. 432. (Tab. XLIV. B).*

HAB. Key West, W.H.H., *Prof. Tuomey*. (No. 103). (v. v.)

*Fronde*s at first globose, like tubers, heaped together, hollow and empty or filled with sea-water, attached to the rock and to each other by a few short, rooting processes ; at length irregularly torn, and then forming expanded, cartilaginous, or skinlike coarsely reticulated membranes. The membrane is wholly composed of a single layer of large, globose, or by mutual compression hexagonal cells, which closely cohere by their sides, leaving the convex ends of the cell free, and these form the surface of the membrane, which when dry resembles a piece of fish skin, or a miniature honeycomb. When the cells have been separated, each is seen to be marked at the line of junction by a double row of circular discs. In full grown cells the primordial utricle is easily separable from the outer cell-wall, and contains a green, granular endochrome ; from which, by cell-division, four new cells are formed, and thus the frond extends by repeated quadrisection of its component cells. The cell-wall is very tough and semifibrous in texture, more like an animal than a vegetable membrane ; and I have seen hairlike processes issue from it internally, analogous perhaps to the fibrous processes of the membrane of *Caulerpa*. I cannot say whether this be a constant character. It was observed in specimens from the Pacific brought home in spirit, and cannot be readily ascertained from dried specimens.

PLATE XLIV. B. *Fig. 1.* *Dictyosphæria favulosa*, the *natural* size. *Fig. 2.* Portion of the surface, showing the division of the cells. *Fig. 3.* One of the cells of which the frond is composed, removed ; the latter figures *magnified*.

ORDER IV.—ULVACEÆ.

Grev. Alg. Brit. p. 168. *Hook. Br. Fl.* 2, p. 309. *Harv. Man.* p. 211. *J. Ag. Alg. Medit.* p. 14. *Endl. 3rd Suppl.* p. 18. *Ulvaceæ et Enteromorpheæ*, Kütz. *Spec. Alg.* pp. 471–475.

DIAGNOSIS. Green or purple, marine or fresh water Algæ, composed of small, polygonal or quadrate cells, forming expanded membranes or membranous sacs or tubes ; rarely arranged in filaments. *Fructification*, zoospores formed in the cells of the frond.

NATURAL CHARACTER. *Root* a small disc, or point of attachment. *Frond* formed of small, often very minute, roundish, quadrate or polygonal cellules cohering together into thin, filmy membranes, of no very definite form, and either expanded into broad leaves, contracted into narrow ribbons, or forming tubes which are either simple or branched. In those of lowest organization, such as *Tetraspora*, the frond is of a nature so loosely gelatinous that it can only by courtesy be called a membrane, and the cells which give it consistency are widely separated by transparent jelly. In *Prasiola* the

cells are closer, with narrower hyaline interspaces, and the gelatine has a firmer consistence, more like that of ordinary cellulose; and in *Ulva* there is perfect cohesion between thin-walled cells, and the membrane formed by them is firm, and often rigid and tough. Perhaps in all cases the cells multiply by a fissiparous division into four, the old cell dividing longitudinally and transversely. This is very obvious wherever the cells stand sufficiently apart, as in *Tetraspora* and *Prasiola*, and in the more transparent *Enteromorpha*; but is less evident in the ordinary marine *Ulvæ*. Most of the *Ulvaceæ* have the brilliant, grass-green common to the Chlorosperms; but in the genera *Porphyra* and *Bangia* the frond assumes a more or less pure dark-purple hue, and hence some authors have removed these genera to the Rhodosperms. But I cannot think such removal natural or desirable; for there is really no difference between *Ulva* and *Porphyra* in structure or fructification, and the occurrence of a purple colour, or even of a purer red, is by no means limited among *Chlorosperms* to these plants. We frequently find purple colours in *Batrachospermeæ*, especially in *Thorea*; they occur also in *Oscillatoriaceæ* and in *Palmellaceæ*; and in the latter, and also in the spores of *Ædogonia* a pure carmine or scarlet is often seen.

The fructification of the *Ulvaceæ* consists in zoospores, which are formed indifferently in all or in any of the cells of the frond, and are furnished with two or four cilia. Their development and germination are beautifully figured by Thuret in his valuable memoir on the zoospores of *Algæ*, in *An. Sc. Nat. Ser. 3, vol. 14*.

Ulvaceæ are universally dispersed either in salt or fresh waters throughout the world, and several are found on damp soil, or in half inundated places. All the genera and most of the species are cosmopolitan. Their specific characters are difficult to fix, and authors differ very much in their opinions respecting them. Kützing describes a multitude of species, which other writers find it difficult to separate, even as varieties. The form of the frond, in the foliaceous species, is assuredly a most uncertain character; and the comparative size and branching of the tube, in the tubular, equally variable.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

* *Porphyreæ* : frond purple.

I. PORPHYRA. Frond leaf-like, purple.

II. BANGIA. Frond filiform, purple.

** *Ulvæ* : frond green.

III. ENTEROMORPHA. Frond membranous, tubular, simple or branched.

IV. ULVA. Frond membranaceous, leaf-like.

V. TETRASPORA. Frond gelatinous, expanded.

I. PORPHYRA. *Ag.*

Frond membranaceous, flat and leaf-like, purple. *Fructification*, dark purple granules (spores) arranged in fours, dispersed over the whole frond.

The species of this genus are difficult to determine, and I am induced, in this place, to unite the *P. vulgaris* and *P. laciniata* of authors, which I have elsewhere (*Phyc. Brit.*) figured and described as distinct. They appear to me to run one into another; and if we contend for two species, with equal justice might we make half-a-dozen. Both are indifferently used in England in the preparation of "*marine sauce*," or laver, which is often brought to table as an accompaniment to roast meat. Kützing describes sixteen species, several of which are probably reduceable to the following:—

I. PORPHYRA *vulgaris*, *Ag.*; frond polymorphous, either undivided or cleft into several broad segments; sometimes peltate, fixed by a middle point. *P. purpurea*, and *P. laciniata*, *Ag. Sp. Alg. p.* 190—191. *P. vulgaris*, *Ag. Aufz. p.* 18. *Harv. Phyc. Brit. t.* 211. *P. laciniata*, *Harv. Phyc. Brit. t.* 92. *Wyatt. Alg. Danm. No.* 32. *P. linearis*, *Grev.* *P. amethysea*, *Kütz.*

HAB. Rocks between tide marks. On the eastern shores from Charleston, South Carolina, to the Arctic Regions. Western Coast, from California to Russian America (v. v.).

Very variable in form in different localities and at different stages of growth. In an early state it is either oblong or linear-lanceolate, with an evident though minute stipes, and then it constitutes the *P. linearis* of Greville, which is found truest to its type in the beginning of winter, in situations near high-water mark, where its vegetation is less vigorous. Later in the season the form usually called *P. vulgaris*, as figured in *Phyc. Brit. t.* 211, will be found in the same locality, and also throughout the whole space between tide marks. In this the frond is ovate or ovato-lanceolate, or broadly lanceolate, much waved at the margin, and without obvious stipe, several inches long and 2–3 inches wide. *P. laciniata*, *Ag.*, which merely differs in having a deeply lobed or divided lamina, grows mixed with the simple variety (*P. vulgaris*); and specimens may easily be found which are intermediate in character. The state called *P. umbilicalis* grows on exposed rocks, generally near low water mark, and looks more like a different species than any of the other varieties. In it the frond is always short, usually of a very dull colour, fixed by a point removed from the margin of the lamina, and therefore somewhat peltate, with the upper side depressed or umbilicate in the centre. This variety is rarely more than two or three inches in length. Other varieties attain to 8 or 10 inches or more.

The colour varies with the age and condition of the fronds. Often it is olivaceous green, with little or no trace of purple; but generally it is of a fine dark purple,

especially when in fructification, the colour being wholly derived from the fructifying cells. The colour also generally becomes more intense and more purple after steeping in fresh water, and in the process of drying; and the dried plant has a very glossy surface, like satin. Sometimes it adheres to paper and sometimes not; and it always shrinks considerably in drying.

II. BANGIA. *Lyngb.*

Frond thread-shaped, tubular, composed of numerous radiating cellules, disposed in transverse rows, and enclosed within a hyaline continuous sheath. *Spores* purple, one formed in each cell of the frond.

This genus was founded by Lyngbye on the *Conf. fusco-purpurea* of Dillwyn, and several other Algæ, both marine and of fresh water, which are more or less nearly allied to it. Some of these have been properly removed. The genus still contains some anomalous species, but the three following appear to me to be con-generic. The genus was first placed by Greville in Ulvaceæ. This position has been questioned, and I was formerly disposed to concur with those who refer it to the neighbourhood of *Lyngbya* in Oscillatorieæ; but a careful examination, especially of *B. vermicularis*, has now convinced me that *Bangia* cannot be far removed from *Porphyra*, to which it bears the same relation that *Enteromorpha* bears to *Ulva*.

1. BANGIA *fuscopurpurea*, Lyngb.; filaments elongated, simple, decumbent, nearly straight, capillary, here and there constricted, forming a brownish-purple, glossy stratum; granules several in each transverse band, dark purple. *Lyngb. Hyd. Dan. p. 83, t. 24. Grev. Alg. Brit., p. 177. Wyatt, Alg. Danm., No. 167. Harv. Phyc. Brit., t. 96. Kütz. Sp. Alg. p. 360. B. atropurpurea, Ag. Syst. p. 76. Alg. Eur. t. 25. Conferva fuscopurpurea, Dillw. t. 92. E. Bot. t. 2055, and C. atropurpurea, Dillw. t. 103. E. Bot. t. 2085.*

HAB. On rocks and wood-work between tide marks. Newfoundland, Herb. *Montagne*. Narragansett Pier, *Prof. Bailey*. Little Compton, *Mr. Olney*. Providence, *M. Charles Giraud*. Lynn, Mass. *Mrs. Estes*. (v. v.).

This is attached to rocks and stones, or to woodwork, and occurs in stratified patches of indefinite extent, of a dark purple colour. The filaments are 2-3 inches long, and float freely in the water, lying down in a fleece when left by the retreating tide. They vary greatly in diameter according to age, and the microscopic characters are equally varied in young and old specimens. In the young state the filament is formed of a

series of very short cells, much shorter than the diameter of the filament ; each containing an undivided mass of dark purple endochrome, and at this age the whole structure is very similar to that of *Hormotrichum*. When further advanced, the endochrome divides longitudinally into many quadrate portions, round each of which a cell membrane grows, and they become so many cells arranged in a radiant manner round a central point, and appear, when viewed from the side, as transverse rows of beadlike granules tessellating the filaments. Eventually, from repeated cell division, the arrangement in transverse lines becomes difficult to observe, and the filament looks like a confused mass of tissue. The number of transverse granules seen in each row depends on age. The figure in *Phyc. Brit.* represents an old state of the plant when the granules have multiplied. The colour under the microscope is a beautiful amethystine purple.

I have only received this plant from the above-named American localities, but it is probably to be found along the rocky shores of all the northern States. In the British Islands it grows indifferently in the sea or in fresh water ; in the latter case it often occurs on the walls and gates of canal locks, and it may be expected to occur in similar situations in America. The specimen from Newfoundland is in a very advanced stage ; the filaments being of large diameter, irregularly constricted, and their granules very numerous in each band, and of minute size. The specimen from Lynn, on the contrary, is very young, with the transverse rows just beginning to be formed.

2. *BANGIA vermicularis*, Harv. ; root scutate ; filaments basifixed, twisted, setaceous at the base, gradually widening upwards and at last claviform, much incrassated toward the end, undulating, flaccid, with a wide, hyaline, firm investing tube ; transverse bands closely placed ; granules dark-purple, vertically flattened, few in each whorl toward the base, very crowded and numerous toward the upper portion of the filament. (TAB. XLIX. A.)

HAB. Golden Gate, California, *A. D. Frye* (v. s. in Herb. T. C. D.)

Filaments fixed at the base by a scutate root, and probably freely floating in the water ; perhaps tufted, but the specimens received have been pulled asunder. Each filament is about two inches long ; at its origin it is of the diameter of human hair ; it becomes gradually thicker upwards, until, near the apex, in old filaments, it is at least twice as thick as hog's bristle. The form is therefore linear-clavate, though the club be very slender in proportion to its length. When dried the threads look like sinuous worms, tapering from a thickened apex to a very slender base. A cross section shows a central cavity surrounded by a variable number of radiating, cuneiform, dark-purple endochromes. Toward the base of the filament there are but four of these in a plane ; a little higher up there are eight, and in the upper portions they are not only indefinitely numerous in the whorl, but they form dichotomous radiating strings extending horizontally from the central tube to the circumference. They do not cohere in regular moniliform filaments, but there seems a tendency to do so. It is difficult, in this part

of the frond, to see the exact cellular structure, owing to the great transparency of the cell-walls, and the facility with which the endochromes are thrown out of their cavities when cross-sections are moistened.

This is a very distinct species, remarkable for the great diameter of its worm-like filaments, and their clavate form. Notwithstanding its somewhat greater complexity of structure, I think there can be no doubt of its near affinity with *B. fuscopurpurea*.

PLATE XLIX. A. *Fig. 1.* *BANGIA vermicularis*, the natural size. *Fig. 2.* A frond magnified. *Fig. 3.* Base ; 4. middle portion ; and 5, apex of the same. *Fig. 6, 7, 8.* Transverse sections at different heights. *Fig. 9 and 10.* Radiating endochrome-cells, all highly magnified.

3. *BANGIA ciliaris*, Carm. ; filaments very minute, (forming a rosy down on the fronds of other Algæ) basifixed, straight ; granules either in a single series, or two or three in each transverse row. *Harv. Phyc. Brit. tab. 322. Chauv. Rech. p. 37.*

HAB. Parasitic on *Chondria atropurpurea*, at Charleston, S. C., *W.H.H. (v. v.)*

This forms a very short, bright, rose-red downy pile on the fronds of the *Chondria*. Each filament is scarcely the tenth of an inch in length, and consists either of a single row of cells shorter than their diameter ; or of a double or triple series of such cells. Possibly it may be only the very young state of *B. fuscopurpurea* ; but the habitat is different, and the colour much brighter.

III. ENTEROMORPHA, *Link.*

Frond tubular, membranaceous, green, reticulated. *Fructification*, granules, commonly in fours, contained in the cells of the frond.

The tubular frond distinguishes this genus from *Ulva*. The tube varies greatly in width, in different or even in the same species. Sometimes it is of no greater diameter than that of human hair ; and sometimes it is one or two inches across, forming an inflated bag. The species are widely dispersed, extremely variable in ramification and general appearance, and some of them are among the commonest of all littoral algæ. The green stringlike weeds that infest the bottoms of boats and vessels lying in harbour are generally species of this genus, and mostly *E. compressa*, which is found in all parts of the ocean from the Arctic and Antarctic basins to the Equator.

1. *ENTEROMORPHA intestinalis*, Link ; fronds perfectly simple, elongated, becoming inflated, obtuse, tapering extremely to the base. *Link, Hor. Phys. Ber. p. 5. Grev. Alg. Brit. p. 179. Harv. Phyc. Brit. t. 154. Wyatt, Alg. Danm. No. 80. E. Bot. Sup. p. 2756. Kütz. Sp. Alg. p. 478. Ulva intestinalis, Linn.*

HAB. Whalefish Islands, Davis's Straits, *Dr. Lyall*. Boston Bay, *Dr. Gray*. Providence, Rhode Island, *Mr. Olney*. New York Bay, *Mr. Walters, &c.* Beesley's Point, *Mr. Ashmead*. Sullivan's Island, *Mr. Ravenel*. (v. v.)

Very variable in the length and breadth of the frond. Old specimens are often much inflated and bag-like ; the frond being 1–2 inches in diameter. Others, often from the same locality, are not more than quarter of an inch in breadth.

2. *ENTEROMORPHA compressa*, Grev. ; fronds elongated, branched, cylindrical or sub-compressed ; the branches simple or nearly so, long, obtuse, much attenuated at the base. *Grev. Alg. Brit. p. 180 t. 18. Harv. Phyc. Brit. tab. 335. Wyatt, Alg. Danm. No. 168. Kütz. Sp. Alg. p. 480.*

HAB. Sea shores, extremely common. (v. v.)

Under one or other of its many forms this species is found on all parts of the American coast extending also up the estuaries of tidal rivers. Our most northern specimens were collected in Lat. 75° 42' by *Dr. Sutherland*.

3. *ENTEROMORPHA clathrata*, Grev. ; frond tubular, tessellated, cylindrical, slender, very much branched ; branches erect or spreading, sometimes squarrose, more or less beset with slender tapering subulate ramuli. *Grev. Alg. Brit. p. 181. E. clathrata, erecta et ramulosa, Hook. Harv. Phyc. Brit. t. 340, t. 43, and t. 245. Wyatt, Alg. Danm. Nos. 34, 166, and 208. E. clathrata, ramulosa, paradoxa, &c. Kütz. Sp. Alg. p. 479.*

HAB. Rock pools, &c. Rhode Island, *Mr. Olney*. Staten Island, New York, *Professor Bailey*. Red Hook, &c., *Messrs. Hooper and Calverley*. Boston Bay, *Captain Pike*. Beesley's Point, *Mr. Ashmead*. (v. v.)

Very variable in appearance, but generally more slender and filiform than *E. compressa*, and also more cylindrical. It is usually densely tufted, capillary, or setaceous, soft to the touch and very much branched ; the branches either erecto-patent or patent ; sometimes horizontal or squarrose, repeatedly decompound, and their ultimate divisions furnished with slender ramuli that taper to a fine point, and are not constricted at base. These ramuli are sometimes very numerous, sometimes few, and either short and spine-like or elongated and filiform. When short, horizontally spreading, numerous and

spinelike, the plant becomes *E. ramulosa* of authors. I have seen the varieties *erecta*, *ramulosa* and *clathrata* from the American coast. The cells of which the walls of the frond are composed are larger and more quadrate than those of *E. compressa*; the surface therefore looks tessellated.

4. ENTEROMORPHA *Hopkirkii*, McCalla; frond excessively slender and byssoid, flaccid, very much branched; branches feathery, decompound, erect, attenuated, set with minute subulate ramuli; cellules large, hyaline, each containing one or two minute grains of endochrome; the ramuli formed of a single series of such cells. *Harv. Phyc. Brit. tab. 263.*

HAB. In rock pools between tide marks. Greenport, *Mr. Hooper.* (v. s.)

Tufts very soft, 3-4 inches long. *Fronde*s very slender and much branched. The frond of this species is composed of much larger and more hyaline cells than in the preceding, and the endochrome is of very minute size in proportion to the cells in which it is lodged. This species occurs also on the shores of England and Ireland; but is not so common as others of the genus, and appears to be sufficiently characterised by its cellular structure. The ramuli are articulated, like the branches of a *Cladophora*.

IV. ULVA. L.

Frond membranaceous, flat, and leaflike, green. *Fructification*; green granules (spores) often arranged in fours, dispersed over the whole frond.

Under this generic name I still retain the species of the modern genera *Prasiola*, *Ulva*, and *Phycoseris*; the first of which differs from the second in having its cellules arranged in a most obviously tessellated pattern; and the last, from either of the preceding, by its membrane consisting of two layers of cells instead of a single layer. The species of the section *Prasiola* are of minute size, and are found in damp places, on the soil, on old walls and on decaying timber and thatch, &c.; and no doubt several (such as *P. crispa*, *P. calophylla*, &c.) occur in America, but I have not received any American specimens. Kützinger describes a *P. mexicana*, Lieb. from Mexico, in words which would apply equally to the *P. crispa* of Europe.

Sect. 1. PHYCOSERIS; membrane formed of a double layer of cellules.

1. ULVA (PHYCOSERIS) *fasciata*, Delile; frond stipitate, cartilagineo-membranaceous, rigid, cleft into several strapshaped segments, which are undulate at the margin, and irregularly toothed or sinuate. *Del. Egypt*, p. 153, t. 58, f. 5. *Mont. Alg. Alger*, p. 151, t. 14, fig. 1-2. *Phycoseris fasciata*, Kütz. *Sp. Alg.* p. 477. *Ulva divisa*, Suhr!

HAB. California, *Dr. Coulter*. Shores of the Gulf of Mexico, *Dr. Schott*. (v. v.)

More rigid than *U. latissima*, and divided into many long narrow segments, half an inch to an inch wide, and 6–8 inches long or more, preserving a nearly equal breadth throughout, and either simple or forking. Sometimes the lacination is almost pinnate, having an undivided leading segment with lateral and often opposite lesser segments. Sometimes the division extends nearly to the base, and the form is then palmate. The margin is mostly toothed, or cut, and frequently undulate. The colour is a full grass green, and the substance rigid. It does not adhere to paper in drying.

I possess authentically named specimens from Montagne and Von Suhr.

2. *ULVA* (PHYCOSERIS) *Linza*, Linn. ; frond linear-lanceolate, acute, crisped at the margin, composed of two membranes closely applied. *Linn. Sp. Pl.* p. 1633. *Ag. Sp. Alg.* 1, p. 413. *Harv. Phyc. Brit.* t. 39. *Wyatt, Alg. Danm.* No. 164. *Phycoseris Linza* and *P. lanceolata*, *Kütz. Sp. Alg.* p. 475, (and probably others.)

HAB. Rocky shores of British America, and of the north-eastern States. Halifax, *W.H.H.* Boston Bay, *Captain Pike*. New York Bay, *Messrs. Calverley, Hooper, &c.* (v. v.)

Root a small disc. *Frond* 6–12 inches long or more, from half inch to one or two inches in width, linear-lanceolate, tapering to the base, and either blunt or attenuated at the apex, much waved and curled at the margin ; formed of two distinct, separable membranes, closely applied and cohering together. *Colour*, a full, brilliant grass green, becoming pale in age. *Substance*, rather soft and thin. It adheres to paper in drying.

Agardh's U. Bertolonii appears to me to be a form of this species, which is also nearly allied to *Enteromorpha intestinalis*, with which, if we omit the inflated frond, there is much similarity in form and structure. It is not so common as the following species, but is nevertheless widely dispersed.

3. *ULVA* (PHYCOSERIS) *latissima*, Linn. ; frond polymorphous, very broad, ovate or oblong, simple or lobed, undulate, bright green. *Lin. Fl. Suec.* p. 433. *Ag. Sp. Alg.* 1, p. 407. *Harv. Phyc. Brit.* tab. 171. *Wyatt, Alg. Danm.* No. 33. *Phycoseris gigantea* and others, *Kütz. Sp. Alg.* p. 476.

HAB. Common on the American coast. (v. v.)

Fronds from six inches to two feet in length, from three to twelve inches in breadth, tufted or scattered ; very variable in shape, sinuated and wavy or flat, often plaited. *Substance*, thin and soft, very smooth and glossy, like fine green silk. *Colour*, a brilliant green, when growing near high water mark ; darker, and often glaucous when obtained from deep water, and sometimes turning brownish in the herbarium.

Specimens are often found pierced with holes, the result either of age or of the attacks of worms. Such individuals constitute the *Phycoseris myriotrema* of Kützinger.

Sect. 2. ULVA. Membrane formed of a single layer of cellules.

4. *ULVA lactuca*, Linn. ; "frond at first obovate, saccate, inflated, at length cleft down to the base ; the segments plane, unequal, laciniated, semi-transparent," *Grev. Lin. Sp. Pl. p. 1632. Ag. Sp. Alg. 1, p. 409. Grev. Crypt. Scot. t. 313. Harv. Phyc. Brit. t. 243. Kütz. Sp. Alg. p. 474.*

HAB. Boston Bay, *Miss E. H. Brewer.* Indianola, Texas, *Dr. Schott.* (v. v.)

Much thinner and more delicate in substance, and of a paler colour than *U. latissima* ; and clearly characterised, on dissection, by its simpler membrane. It is more transparent, and the cells are more regularly grouped in fours, more distant, with hyaline interspaces. When young it forms a bag, like a very short and broad *Enteromorpha*. It closely adheres to paper in drying.

5. *ULVA bullosa*, Roth. ; frond very delicate, gelatinoso-membranaceous, at first saccate, afterwards bursting, and opening out into a broad, wavy or torn floating membrane. *Roth, Cat. Bot. 3, p. 329. Ag. Sp. Alg. 1, p. 414. Harv. Man. Ed. 1, p. 171. Hass. Br. Fr. Wat. Alg. p. 297, t. 78, fig. 13. Tetraspora bullosa, Kütz. Sp. Alg. p. 226.*

HAB. In fresh-water ponds and ditches. Whalefish Islands, Davis's Straits, *Dr. Lyall.* (v. v.)

Probably as common in stagnant pools in America as it is in Europe, but I have as yet only seen specimens brought from the Arctic Regions by Dr. Lyall. When young it is attached, and somewhat tubular, like large specimens of *Ent. intestinalis* ; but it afterwards bursts open, and then generally floats on the surface, being buoyed up by bubbles of oxygen, which it disengages.

By Kützinger this species is referred to *Tetraspora*, from which it scarcely differs by any definite character.

V. TETRASPORA. *Link.*

Frond gelatinoso-membranaceous, tubular, inflated or flat, green. *Fructification*, green granules (spores) arranged in fours, dispersed throughout the hyaline cells of the frond. (*In fresh water.*)

This genus scarcely differs from *Ulva* on the one side and *Palmella* on the other. The frond is more gelatinous than in *Ulva*; and more membranous than in *Palmella*. The whole of the endochrome is converted into spores, which are arranged in squares and more distantly placed than in *Ulva*.

1. *TETRASPORA lacunosa*, Chauv.; frond at first tubular, then flat, or irregularly lobed, membranaceo-gelatinous, pale-green, everywhere pierced with roundish holes of various sizes. *Chauv. Alg. Norm. Breb. Alg. Fal. p. 11, t. 1. Kütz. Sp. Alg. p. 227. T. Godeyi, De Breb. Kütz. Tab. Phyc. t. 30, f. 3. T. perforata, Bailey, M.S.*

HAB. In fresh-water streams. Abundant near Westpoint, *Prof. Bailey*. Providence, Rhode Island, *Mr. Olney*. (v. s. in Herb. T.C.D.)

Frond at first funnel-shaped, afterwards splitting open, and then flat, expanding upwards and irregularly lobed, everywhere pierced with roundish holes of various sizes, large and small intermixed. These holes increase in size and numbers with age, and thus at last the frond becomes an open network. The substance is very gelatinous, but rather firmer than in some other species of the genus. The colour is a pale green; and the hyaline gelatinous membrane is filled with roundish granules set in fours.

Kützinger's figure of *T. Godeyi* answers well to our plant. I have not seen any authentic specimens of *T. lacunosa*, which is referred by Kützinger to his *T. lubrica*, var. β ., but the description given of it applies to the American plant. When carefully dried, it forms a very pretty object for the Herbarium.

ORDER V.—BATRACHOSPERMEÆ.

BATRACHOSPERMEÆ, *Ag. Syst. p. 23, (partly) Harv. Man. Ed. 1, p. 119. Berk. Crypt. Bot. p. 136, Dne. class, p. 33 (partly.) Kütz. Sp. Alg. p. 535. Lemanieæ, Ag. Sp. Alg. 2, p. 1. Harv. Man. Ed. 1, p. 118, Dne. Class, p. 31. Kütz. Sp. Alg. p. 527 (partly.)*

DIAGNOSIS. Blackish-green, olivaceous or purplish fresh water Algæ, with filiform, branching, inarticulate fronds, composed of small cells; naked, or whorled with moniliform ramelli. *Fructification*; moniliform strings of naked spores, either forming external tufts, or concealed within a tubular frond.

NATURAL CHARACTER. *Root* merely a point of attachment or little disc, by which the frond is firmly fixed to the substances (usually rocks and stones in rapid rivers and

streams) on which it grows. The plants referred to this Order naturally group themselves into two suborders, distinguished from each other by the habit of the frond, but closely related in structure and fructification, and as it seems to me inseparably connected by the genus *Tuomeya*, which unites in itself the characters of the seemingly so dissimilar genera *Batrachospermum* and *Lemanea*. In the first suborder (*Batrachospermeæ veræ*) the branching filiform frond consists of a solid axis, invested with a gelatinous coating, and composed of vertical, confervoid filaments, strongly glued together. This axis is either, as in *Batrachospermum*, whorled at short intervals with moniliform ramelli, formed of globose cellules strung together; or else, as in *Thorea*, it is uniformly clothed with a villous stratum of byssoid ramelli, formed of cylindrical cellules. The fructification, so far as known in this suborder, consists of globular, very dense tufts of spore-threads, similar in structure to the ramelli, but of more minute size, and far more densely packed together. I question whether they be properly *spores*, probably they are rather highly developed or compound *gemmae*. In the second suborder, *Lemanieæ*, the frond is denuded of confervoid ramelli, and consists altogether of a compound, filiform axis, composed of minute cells. In *Lemanea* the frond is hollow and tubular, the walls of the tube being laxly constructed within; and moniliform strings of spores, similar to those of *Batrachospermum*, are attached to the surface of the tube. This structure is almost the exact reverse of that of *Batrachospermeæ*, where the central axis is most solid, and clothed *externally* with moniliform filaments. In *Tuomeya* the frond has at first the external characters of a *Lemanea*, but is furnished with an *axis* having the structure of a *Batrachospermum*, as if a *Batrachospermum* were developed within the tube of a *Lemanea*; and when fully developed the surface is uniformly coated with minute filaments, as in *Thorea*.

Authors differ much in their views of the proper limits of this Order. Decaisne unites with it *Liagora* and *Dichotomaria* (*Galaxaura*) both of which are undoubtedly Rhodosperms; and *Myriocladia*, which is a Melanosperm. Kützing separates *Batrachospermum* as the type of an Order of which it is the only genus; while he refers *Galaxaura*, *Actinotrichia* and *Lemanea* to his *Lemanieæ*; and places *Thorea* with his *Chætophorideæ*. My own views more nearly correspond with those of Mr. Berkeley, who brings *Batrachospermum*, *Thorea*, and *Lemanea* together into one Order. These genera are exclusively fluviatile or lacustrine, so far as I am aware. The *marine* variety "*purpurascens*," Roth, of *Batr. moniliforme* is founded on a figure of Dillenius (*Hist. Musc. t. 7. fig. 40*) which certainly looks very like a *Batrachospermum*, but the original specimen preserved in the Dillenian Herbarium belongs, according to Turner, to *Ceramium diaphanum*. The marine "*Thorea Americana*" of Kütz. is assuredly not a congener with *T. ramosissima*, the type of the genus; but properly referred by Bory, who first described it, to *Chordaria*.

Like most fresh water Algæ, several of the species are widely distributed. *Batrachospermum moniliforme* is found throughout Europe in various parts of Asia, in Tasmania and New Zealand, and in extra-tropical South America; and *B. vagum* and *atrum*, of which as yet I have seen no North American specimens, have nearly as extensive a range. *Lemanea torulosa* occurs in Europe. *Tuomeya fluviatilis* has only as yet been found in North America, but occurs in distant localities (New York and Alabama) and may probably be found to have a much larger area of distribution,

TABLE OF THE NORTH AMERICAN GENERA.

Sub-Order I. BATRACHOSPERMEÆ; *Frond* filamentous, gelatinous, externally clothed with minute articulated ramelli.

I. BATRACHOSPERMUM. *Frond* nodose, ramelli whorled.

Sub-Order II. LEMANIEÆ. *Frond* cartilaginous, solid or hollow, with a cellular peripheric stratum.

II. TUOMEYA. *Frond* solid, with a filiform, nodoso-articulate axis.

III. LEMANEA. *Frond* hollow.

I. BATRACHOSPERMUM. *Roth.*

Root discoid. *Frond* filamentous, gelatinous, branched, consisting of an articulated longitudinally striated *axis* beset with closely placed whorls of moniliform, free ramelli. *Fructification*, globose clusters of seriated spores, attached to the ramelli. *In fresh water.*

Widely dispersed plants inhabiting clear fresh-water streams and wells in most parts of the world; rarely found in stagnant waters. Several species have been described, but the characters of many are unsatisfactory. All are exceedingly gelatinous, every part of the frond being invested with a clear, rather firm mucus, and when removed from the water the collapsed branches have the colour and general aspect and feel of *frog-spawn*; whence the generic name. Kützing, in Plate 8 of his *Phycologia Generalis*, has given figures to illustrate the early development and gradual formation of the frond. At first the young plant consists merely of a string of moniliform cells. Soon there is a distinction into an axis and ramelli, the axis consisting of a series of long, pellucid cylindrical cells, placed one above the other; and the ramelli being more coloured, formed of roundish cellules, and placed at the nodes of the axial filament, round which they gradually form a whorl. At first these ramelli are simple; afterwards they are repeatedly dichotomous. The *axis* in the young plant consists merely of a string of naked cells; in the full-grown frond it is invested with a sheath or outer coat formed of slender filaments which issue from the bases of the whorled ramelli, growing downwards like roots, adherent to the axis and continued to the next node. These give the longitudinally striate appearance to the axial filament; and in old fronds they constitute the axis itself, which then becomes tubular, from the absorption or rupture of the primordial tube.

1. BATRACHOSPERMUM *moniliforme*, Roth.; frond irregularly much branched, very

gelatinous; whorls of ramelli globose, distinct, the branches resembling strings of beads. *Kütz. Sp. Alg.* 1, p. 535. *Harv. Man. Ed.* 1, p. 119. *Hass. Brit. Fr. Wat. Alg.* p. 108. *Conferva gelatinosa*, Dillw. *Conf. t.* 32. *E. Bot. t.* 689.

HAB. On stones, &c. in running streams and wells of fresh water. New York, *Prof. Bailey*, *Mr. Calverley*. Virginia, *Mr. Jackson*. Alabama, *Prof. Tuomey*. South Carolina, *Mr. H. W. Ravenel*. Michigan, *Dr. A. Gray*. (v. v.)

Fronde densely tufted, gelatinous, capillary, irregularly much branched, decompound, the branches tapering to their extremity, beset with short tapering ramelli, which are very patent and once or twice divided. All the branches and ramuli are moniliform, and are composed of a filiform cylindrical axis; set at short intervals with very dense, globose whorls of multipartite, dichotomous ramelli. The axis is formed of an articulated monosiphonous filament, externally coated with a sheath of closely-placed, cohering, longitudinal, parallel, articulated, very slender filaments, derived from the bases of the whorled ramelli, and developed along the internodes from above downwards. The *ramelli* are excessively branched, and composed of short cells much constricted at the points of union; the lower ones are somewhat pyriform, the upper lanceolate. The masses of fructification are very dense, appearing to the naked eye like black grains among the ramelli. When examined, by squeezing between two glasses on the table of the microscope, they are seen to consist of exceedingly densely packed, minute, dichotomous ramelli, radiating from a common centre. These ramelli scarcely differ in structure from those of the ordinary whorls, and can scarcely be regarded as composed of true *spores*; but seem to be rather of the nature of *gemmae*. The general colour of this species varies much: commonly it is a dark slate colour, sometimes it is olive-green, and often becomes purple after having been dried.

B. moniliforme is found in most parts of the world. It is very common in fresh-water streams in Europe; and we have received it from Van Diemen's Land, New Zealand, and Cape Horn.

II. TUOMEYA. *Harv.* (Nov. Gen.)

Frond cartilaginous, continuous, solid, at first transversely banded, afterwards annularly constricted; composed of a longitudinal axis, and two strata of peripheric cells. *Axis* columnar, consisting of several longitudinal, cohering filaments, beset with closely placed whorls of moniliform ramelli, whose branches anastomose horizontally and vertically into a cellular peripheric membrane, which is coated externally with moniliform filaments, gradually developed. *Fructification* (probably in the superficial filaments.) *In fresh water.*

TUOMEYA *fluvialis*, Harv.

HAB. On stones, in rivers and streams. River in Alabama, *Prof. Tuomey*. Near Fredericksburg, Virginia, *Prof. Bailey*. (v. s. in Herb. T.C.D.)

Fronds tufted, an inch or two in height, scarcely as thick as hog's bristle, much and irregularly branched, bushy; the branches alternate or secund, scattered or crowded, twice or thrice divided, and set with scattered, patent ramuli, which are slightly constricted at the insertions, and taper to an obtuse point. When young the branches and ramuli are perfectly cylindrical, and when examined under a low power of the microscope show a surface composed of minute, dotlike cells, placed close together, and marked at short intervals with dark coloured transverse bands. These bands disappear under a higher magnifying power. They are indications of the *nodes* of the axis of the frond, seen through the peripheric stratum. In old, fully developed specimens the branches and ramuli are annularly constricted at short intervals, the nodes becoming swollen, while the internodes remain unchanged. When a young branch is bruised between two pieces of glass the axis may be readily extracted. It consists of several parallel, longitudinal, jointed threads combined together at closely placed *nodes*, from which issue horizontal dichotomous filaments composed of roundish or angular cells. These excurrent filaments spread both horizontally and vertically, and their branches anastomose into a cellular mass or fleshy membrane which forms the inner peripheric stratum. In young plants a portion of the frond, between the axis and periphery, is hollow, but in older ones the cavity is quite filled up with cells. The external surface of the cellular periphery is clothed with a coat of moniliform filaments gradually developed, and forms what is above called the *second* peripheric stratum. These are found only in fully grown specimens; they consist of much smaller cells than those of the inner stratum; they are more strongly coloured, and I consider them to be connected with fructification. The *colour* is a dark olive. The substance is brittle and rigid when dry; and the plant scarcely adheres to paper.

I formerly received specimens of this curious little plant from my late friend Prof. Bailey, under the name "*Lemanea fluviatilis*;" but, as may be gathered from the above description, it is very different from *Lemanea* in structure and much more nearly related to *Batrachospermum*. The external habit, substance, and colour are however those of a *Lemanea*, and without microscopic examination it might pass for one. The structure is difficult to see and also to describe in words. What I have called the inner peripheric stratum is externally as solid as the walls of a *Lemanea*; the outer periphery consists in a continuous clothing of the external surface of the frond with minute, fastigate, horizontal ramelli, not unlike those of which the globose fructifications of a *Batrachospermum* are made up. In young specimens only can the mode of evolution of the frond be observed; old specimens become completely blocked up with cellular tissue, and seem to be solid in every part when a transverse slice is examined; their axis may, however, be seen by employing a compressing glass.

The generic name is bestowed in memory of the late Prof. Tuomey of Tuscalosa, Alabama, so often mentioned as a valuable contributor to these pages. I have not ventured to make a drawing from the dried specimens which alone I have yet seen.

III. LEMANEA, *Bory.*

Frond cartilaginous, continuous, tubular, branched, its periphery composed of two strata of cells, the *inner* stratum formed of roundish, empty, vesicated cells ; the *outer*, of minute, closely cohering, angular, coloured cellules. *Fruit*, tufts of seriated spores, attached to the inner surface of the tubular frond. (*In fresh water streams and rivers.*)

The species referred to this genus are found in fresh water streams and rivers, attached to stones by a discoid root. They are very dissimilar in appearance from other fresh water algæ, being of a remarkably firm fucoid substance, opaque and closely cellular. In many respects, however, they approach *Batrachospermum*, near which genus I have long considered to be their true systemic position, an opinion which must be considered as confirmed by the discovery of *Tuomeya*, a genus of intermediate structure. Kützing associates *Lemanea* with *Galaxaura* and *Actinotrichia*, two genera that appear to me to belong to HELMINTHOCLADIÆ, among the Rhodospermatous groups. Thwaites has given in the 20th vol. of Linn. Trans. a short account of the early development of the frond in *L. fluviatilis*. The spores at first vegetate into confervoid, slender jointed filaments, with long joints containing a spirally arranged endochrome. These constitute a sort of pro-thallus, or pseudo-colytedonous condition of the plant. After a time thick branchlets, the germs of the permanent frond, spring from the cells of the confervoid filament ; they are at first wholly dependent on the cell from which they rise, but soon acquire rootlets at their base, and rapidly elongating grow into the cellular, opaque, cartilaginous fronds characteristic of the genus. Kützing, *Phyc. Gen.* t. 19, also illustrates the early development, and gives elaborate sections of the cellular structure of the mature frond.

1. *LEMANEA torulosa*, Ag.; frond tufted, subsimple or divided near the base, robust, nodoso-constricted at short intervals, or moniliform, tapering from the base to the apex. *Ag. Sp. Alg.* 2, p. 6. *Act. Holm.* 1814. tab. 2, fig. 1. *Kütz. Sp. Alg.* p. 528. *L. variegata*, Ag.? *l. c.* p. 7.

HAB. On rocks and stones in rivers and streams. Kentucky, *Dr. Short.* (v. s.)

Root discoid. *Stems* many from the same base, 4--8 inches long or more, twice or thrice as thick as hog's bristle, rising from a very slender, capillary base, and gradually increasing in diameter upwards for about an inch, thence maintaining an equal diameter for $\frac{3}{4}$ of their length, and again tapering off at the extremity ; either quite simple or divided shortly above the base into numerous simple branches. The frond is regularly constricted and swollen at intervals of from one to two lines, so as to be nodose in the younger, and moniliform in the more advanced state, the distances between the swellings as well as their intensity varying in different specimens. The walls of the tubular frond are thick, composed of two layers of cells, the outer layer consisting of very minute and closely crowded radiant, coloured cellules, whose apices unite to form the exterior

coating of the frond, the inner of three or four rows of large, colourless, oblong, irregularly anastomosing cells. The tube is traversed and crossed by a few slender, cylindrical, long jointed filaments issuing from the inner peripheric cells. *Globose* masses of *fructification* are attached to the inner face of the tubular frond, either at the nodes or between them, without any apparent order. They consist (as in *Batrachospermum*) of very densely crowded, moniliform, subsimple strings of cellules radiating from a central point. The general *colour* is olivaceous when recent, and very opaque; it becomes a livid purplish in drying. *Substance* firmly cartilaginous or subcoriaceous. It does not adhere to paper in drying.

Agardh describes a *L. variegata*, "filis moniliformibus variegatis," as sent to him by Muhlenberg, from North America. By the description given it seems merely to differ from the common *L. torulosa* in being variegated with alternate bands of dark and pale, a character most probably dependant on the state of the specimens. I am indebted to Dr. Short of Kentucky, for fine specimens of the ordinary form. *L. fluviatilis*, which is the commonest European species, has not been sent to me from America.

ORDER VI. CONFERVACEÆ.

Confervæ, J. Ag. Alg. Medit. p. 12. Harv. Man. Ed. 1 and Ed. 2, p. 196. Lindl. Veg. Kingd. p. 18. *Confervoideæ*, Endl. 3d Supp. p. 14. *Confervaceæ*, Berk. Crypt. Bot. p. 131. *Confervaceæ* and *Chætophoroideæ*, (partly) Dne. class, p. 31, Kutz. Sp. Alg. pp. 363-531.

DIAGNOSIS. Green, marine or fresh water Algæ, composed of articulated threads or filaments, and of cylindrical cells usually longer than their diameter. *Endochrome* diffused, or filling the cavity of the cell. *Zoospores* minute, indefinitely numerous in each cell.

NATURAL CHARACTER. *Root* rarely more than a mere point of attachment, and often perishing on the evolution of the frond, which then floats on the surface of the water. *Frond* in all cases filamentous, composed of strings of truncated, more or less cylindrical cells, placed end to end, and usually longer than their diameter. These cells are never branched, like those of the *Siphonaceæ*, and are usually much shorter in proportion to their diameter than in that order; but as compared with those of most of the filamentous Algæ they are long, varying however extremely in different species. The endochrome generally fills the cavity or primordial utricle of the cell, but varies greatly in density. In some cases it is thin and watery, and in others very dense, granular, and subopaque. It is sometimes arranged in transverse bands. In most cases the cell wall is membranaceous, soft, but of firm texture; but in *Draparnaldia* and *Chætophora*, the filaments are invested with gelatine, and in the latter genus numerous

filaments are enclosed within a common gelatinous envelope, and thus formed into somewhat compound fronds. In the great bulk of the Order no fructification other than minute *zoospores* has been observed. These are formed out of the colouring matter of the cells, are furnished with vibratile cilia, and when they escape from the cell in which they have been organised, enjoy for a time active powers of locomotion. At length fixing themselves to some object they change their form, becoming cylindrical; and then, dividing repeatedly, are changed into articulated filaments similar to those of the parent plant. In the *Confervæ* the frond lengthens in two ways; either by the repeated bisection of all the cells of the frond, as is usually the case in the unbranched species; or by the evolution of new cells, constantly at the apex of the terminal cell, as is common in the branching species. In these latter the cell, after having once formed one or more new cells out of its apex by a cutting off of the summit from the basal portion, remains unchanged, without further growth or cell division. If but one new cell be formed at the apex, the filament will be simple; but in the branched species two or more cells are formed, the central one continuing the frond, while the lateral ones, which spring just below the summit of the old cell, grow out into branches.

The Confervaceæ are almost universally dispersed in water of every character found on the surface of the globe. Many are marine, but perhaps the largest number, at least of individuals, if not of species, are found in fresh water. The marine species usually grow within tidal limits, but several of the *Cladophoræ* occur in the Laminarian zone, and some even at a greater depth. The fresh water species are found in lakes and ponds, in rivers, streams, and wells, and in thermal springs or in mineral waters. A large number of genera and species have been described; but I fear the proper number of both genera and species has been much exaggerated, and that multitudes must be erased from the list whenever the Order shall be carefully revised. The fresh water species have as yet scarcely been attended to in America. I have received very few of these, and most of them in a state unfit for examination. Indeed, dried specimens of such obscure algæ are of little value for determining species. A few of the more remarkable are here described; being all those that I can clearly make out from the specimens received. It is, however, often a difficult task either to refer one of these species to its supposed type, or to devise specific characters that shall not be illusory for what appear to be new forms. The characters usually insisted on, namely, the length of the cells as compared with their diameter, the absolute diameter of the cell, and the degree of ramification of the filament, are all subject to much variation. There appear to be no definite limits to any of these characters in any species. We are forced therefore, in describing them, to be content with rude approximations. Figures are of little use, for in many of the species, such as *Cladophora glomerata*, scarcely two specimens are in all respects similar.

TABLE OF THE NORTH AMERICAN GENERA.

Sub-order 1. CHÆTOPHOREÆ. Frond invested with gelatine.

I. CHÆTOPHORA. Numerous filaments combined into a gelatinous frond of definite form.

II. DRAPARNALDIA. Filaments separate, fasciculately ramulose.

Sub-order 2. CONFERVEÆ. Frond destitute of a gelatinous coating.

III. CLADOPHORA. Filaments tufted, erect, branched.

IV. CHÆTOMORPHA. Filaments unbranched, membranaceous, with a thin cell-wall.

V. HORMOTRICHUM. Filaments unbranched, gelatino-membranaceous, with a thick cell-wall ; nodes constricted.

VI. RHIZOCLONIUM. Filaments decumbent, spuriously branched, the branches few and rootlike.

I. CHÆTOPHORA. *Ag.*

Frond gelatinous, polymorphous, of definite form ; the gelatine tranversed by many filaments aggregated together and issuing from a common base. *Filaments* articulated, branched ; articulations of the branches nearly hyaline, those of the ramuli filled with green endochrome. *Sporangia* globose, attached to the ramuli. *Zoospores* formed in the articulations. (*In fresh water.*)

The species form gelatinous masses, of definite or sub-indefinite form, attached to sticks, water-plants, or stones, in stagnant or running water. The gelatine is colourless, tolerably firm and tenacious, and when a portion is placed under the microscope is seen to be traversed in every part with slender, articulated, branching filaments, variously arranged. The filaments are dimorphous, that is, their main divisions are formed of differently shaped cells from those that compose the ramuli. The latter alone contain much endochrome. *Fructification* has, as yet, been seen only in very few species. In some stage of growth the terminal cell of the ramuli is tipped with a very long, hyaline bristle, whence the generic name, from *χαιρη*, a *bristle*, and *φορεω*, to *bear*. The two following species have been sent me from America ; both are common European plants. Probably several others occur in American waters.

1. CHÆTOPHORA *endiviacifolia*, *Ag.* ; frond elongate, irregularly much branched ; branches linear, scattered, or fasciculate, very patent, dichotomous or pinnate, or secundly ramulose ; longitudinal filaments parallel, hyaline, or transversely banded,

emitting at short intervals tufts of multifid bright-green ramuli. *Ag. Syst. Alg.* p. 28. *Lyngb. Hyd. Dan. t.* 65, *fig. C.* *Kutz. Sp. Alg.* p. 532. *Hass. Brit. Fr. W. Alg.* p. 125, *t.* 9, *fig.* 1-2.

HAB. On sticks and stones, in running streams and ponds. Near West Point, *Prof. Bailey*. Cumberland, Rhode Island, *Mr. Olney*. South Carolina, *Mr. Ravenel*. (v. v.)

Frond gelatinous, varying greatly in size and in ramification; the younger specimens thicker, with fewer branches; the older attenuated and compound. The American specimens before me are 1-3 inches long, and from 1-2 inches in the expansion of the branches. Their fronds are not more than half a line in diameter, linear, filiform, and excessively branched, the branches very much crowded on a prolonged axis, from which they issue without order and are directed to all sides. They are sub-dichotomous, and more or less densely set with divaricated, simple or forked ramuli. When a portion of a branch is examined with a magnifier, it is seen to be composed of several parallel, longitudinal, articulated filaments, lying apart from each other, being separated by a gelatinous matrix; their cells are 4-6 times as long as broad, hyaline or marked with a central transverse band of granules, and they emit, at short intervals, horizontally spreading, multifid, coloured ramuli. The branching of the ramuli is irregular, and between fasciculate and pinnate, the ramification being sometimes densely crowded, sometimes distant. The cells of these ramuli are filled with green endochrome; they are 2-3 times as long as broad, and the terminal cells, which are short, are either simple or carry at their summit a long bristle-shaped acumination. *Substance* gelatinous. The plant closely adheres to paper in drying.

This species occurs in fresh-water ponds and streams in all parts of Europe, and its many minor varieties have received several names. All agree in microscopic structure. The ramification of the gelatinous matrix alone is variable, and that is a character of very little moment. Professor Bailey's specimens are labelled "*Batrachospermum Americanum*, Schweinitz;" a synonym referred by Agardh to his *Draparnaldia opposita*, which is quite different from the Alga now described.

2. *CHÆTOPHORA pisiformis*, Ag.; frond globose, carnosogelatinous, formed of numerous erect, radiating, sub-parallel filaments emitting to the circumference dichotomomultifid patent branches. *Ag. Syst.* p. 27. *Hass. Brit. Fr. Wat. Alg.* p. 128, *t.* 9, *fig.* 5-6. *Kutz. Sp. Alg.* p. 532.

HAB. On sticks, in fresh-water ponds and ditches. Dr. Witt's Meadow, New York, *Prof. Bailey*. (v. v.)

Frond the size of a pea, or less, globose, several occurring together on the same stick, gelatinous, but rather firm, bright green. When bruised between two glasses, and examined under the microscope, the gelatinous matrix which forms the globe is seen to be everywhere filled with much branched filaments which rise from the base and radiate

towards all parts of the circumference, sending forth multifid coloured branches vertically and laterally. The articulations of the filaments are once, twice or thrice as long as their diameter in different parts, contracted at the dissepiments, and filled with bright green endochrome. In a young state the apices of the ramuli are prolonged into setæ, or needleshaped, colourless acuminate cells, but these are deciduous in this and other species of the genus. *Colour*, a bright green.

Possibly this species is only a small state of *C. elegans*.

II. DRAPARNALDIA, Bory.

Filaments separate, gelatinous, articulated, dimorphous; the articulations of the stem and branches hyaline, transversely banded; those of the ramuli filled with green endochrome. *Zoospores* formed in the articulations. (*In fresh water.*)

Very beautiful, and extremely gelatinous, bright green, filamentous, much branched Algæ, found in clear wells and gentle streams. The structure of the filaments is similar to that of the filaments of the *Chætophoræ*; and this genus merely differs from the preceding in its filaments being separate one from another, and not combined by means of gelatine into a compound frond. It therefore bears the same relation to *Chætophora* that *Vaucheria* does to *Codium*. The name was bestowed by Bory de S. Vincent in honour of M. Draparnaud, a French naturalist.

1. *DRAPARNALDIA opposita*, Ag.; frond vaguely much branched; joints of the main filament as long as broad, or shorter; pencils of ramuli mostly opposite, densely set, lanceolate-acuminate in outline, plumose, bi-tripinnate, the apices much attenuated. *Ag. Syst. p. 59. Kütz. Sp. Alg. 357. Lyngb. Hyd. Dan. tab. 65, fig. A. Batrachospermum Americanum, Schweinitz.*

HAB. In clear streams. New York, *Professor Bailey*. New Jersey, *Mr. Jackson*. (v. s.)

Frond 2-3 inches long, gelatinous, capillary, irregularly much branched; the branches patent, lateral, more or less divided, and set with lesser ramuli. Main filaments with short articulations, as long as their breadth or shorter, transversely banded. At every two or three nodes and sometimes at every node a pair of opposite penicillato-multifid ramuli are thrown off. These are bright green, ovato-lanceolate in outline, much acuminate and twice or thrice pinnate, their pinnules somewhat constricted at the nodes, and tapering at the apex into long, needle-like, hyaline points. Their cells are commonly nucleated and filled with endochrome.

Whether this be permanently distinguishable from *D. glomerata* is doubtful. It has externally the aspect of that species, but its microscopic characters are nearer those of *D. plumosa*.

2. *DRAPARNALDIA glomerata*, Ag.; frond vaguely much branched; articulations of the main stems once or twice as long as broad, swollen in the middle; pencils of ramuli alternate or scattered, often distant, ovate in outline, fasciculato-multifid. *Ag. Syst. p.* 58. *Kütz. Sp. Alg. p.* 356. *Lyngb. Hyd. Dan. t.* 64. *Hass. Brit. Fr. W. Alg. p.* 120, *tab.* 13, *f.* 1. *Conferva mutabilis*, *Dillw. Conf. t.* 12. *E. Bot. t.* 1746.

HAB. In clear streams. New York, *Professor Bailey*. Rhode Island, *Mr. Olney*. (v. v.)

Very similar to the last species, but less densely plumose, with scattered fascicles of ramuli.

3. *DRAPARNALDIA plumosa*, Ag.; frond very slender, elongate, much branched; joints of the main filaments once or twice as long as broad; pencils of ramuli opposite or whorled, plumose, much attenuated, pinnate or bi-pinnate, the apices of the pinnules acicular. *Ag. Syst. p.* 58. *Kütz. Sp. Alg. p.* 357. *Hass. Brit. Fr. W. Alg. p.* 121. *tab.* 12, *f.* 1.

HAB. In streams. West Point, *Professor Bailey*. (v. v.)

More slender than *D. glomerata*, and much more branched, forming dense, gelatinous tufts, 3-6 inches long, often much drawn out in running water. In the American specimens the articulations of the stem and branches are about twice as long as broad, slightly constricted at the nodes, and swollen in the middle. Several seriated cells of this length follow each other, and then occur two or three short, nearly globular cells consecutively, which shorter cells emit the opposite or ternary penicillate ramuli. This alternation of longer and shorter cells occurs throughout the branch, the shorter ones always producing the ramuli. The ramuli are pinnate or bi-pinnate, but much less compound than in *D. opposita* or *D. glomerata*.

The synonymy of this species is confused. The American plant differs slightly from the European specimens with which I have compared it, but I am not disposed to think it specifically different. Indeed the three forms now described as species are so similar in all essential respects, that it may well be questioned whether they should be kept separate.

III. CLADOPHORA. *Kütz.*

Filaments (not gelatinous) tufted, articulated, uniform, branched. *Articulations* filled with green, granular endochrome, which is changed at maturity into *zoospores*. (*Marine or in fresh water.*)

An immense genus, in which, for the present, are placed almost all the branching

species of a *green* colour formerly referred to the genus *Conferva*. The species are extremely difficult to define, and have been unreasonably multiplied; but are so much diversified that it is difficult to avoid giving different names to the many forms met with, if they are to be described at all. Kützing admits 210 species, and probably nearly 100 more have been described by other authors. A wholesale reduction will probably be eventually made. I have referred most of the American forms, approximately or absolutely, to European types; in some cases perhaps incorrectly. But unless better specific characters than those at present in use shall be discovered, it is almost impossible to find words to characterise, as distinct, nearly allied forms. When, therefore, I meet with an American specimen reasonably like a European, I here place them under the same head, or specific name. Several doubtful specimens I have been unable satisfactorily to identify, and hold them over for future examination, should better materials be sent to me.

Sect. 1.—*Species found in the sea.*

* CÆSPITOSÆ. Filaments short, rigid, densely interwoven into cushion-like tufts.

1. *CLADOPHORA repens*, J. Ag.; filaments short, emitting root-like processes, densely interwoven into globose or expanded mats, capillary, rather rigid, sparingly and very irregularly branched; branches erect, subsimple, filiform, naked or having a few secund ramuli; articulations cylindrical, many (10–20) times as long as their diameter. *J. Ag. Alg. Medit. p. 13. Harv. Phyc. Brit. t. 236. Kütz. Sp. Alg. p. 416.*

HAB. On rocks, &c. in the sea. Key West, *W. H. H.* (v. v.)

Tufts very dense, an inch or two in breadth and about half an inch high, cushion-like, composed of innumerable, interwoven, capillary filaments. The filaments are at first decumbent, and connected by rootlike fibres which form the substratum of the mat; the branches are erect, simple or branched, with or without secondary ramuli. The articulations vary greatly in length in specimens from different localities.

This species is a native of the Mediterranean, and also of the British Channel Islands. Except in the length of the articulations, which also vary much in the same filament, the European and American specimens nearly coincide.

2. *CLADOPHORA membranacea*, Ag.; filaments short, creeping, densely interwoven into globose or expanded mats, somewhat fastigiate, thick, almost setaceous, flaccid, membranaceous, sparingly and irregularly branched; articulations many times longer than broad. *Ag. Syst. p. 120. Kütz. Sp. Alg. p. 415.*

HAB. On rocks and the smaller Algæ. Key West, *W. H. H.*, *Professor Tuomey.* (v. v.)

Matted tufts an inch or more in diameter, sometimes widely spreading. *Filaments* scarcely an inch long, rising from creeping fibres, sparingly branched, flaccid, the branches very irregular, few or many, either undivided or once or twice compounded, naked, or having a few secund ramuli toward the ends. *Articulations*, especially the lower ones, very many times longer than broad, their membrane thin and membranous. *Colour* a very pale green, with watery endochrome.

This has the densely matted habit of the preceding species, but the filaments of which the mats are composed are much more robust, and less rigid, of a paler green, &c. Kützing well observes that it has the aspect of a *Valonia*.

** RUPESTRES ; rigid, dark-green, tufted ; the cell-wall thick.

3. *CLADOPHORA rupestris*, L.; filaments capillary, rigid, dark-green, straight, tufted, bushy ; branches erect, crowded, densely clothed with appressed, opposite or tufted, subulate ramuli ; articulations three or four times as long as broad. *Linn. Sp. Pl. p.* 1637. *Dillw. Conf. t.* 23. *E. Bot. t.* 1699. *Harv. Phyc. Brit. t.* 130. *Kütz. Sp. Alg. p.* 396. *Wyatt, Alg. Danm. No.* 95.

HAB. Rocky shores, near low water mark. Fiskernaes, near Cape Farewell, Greenland, *Dr. Sutherland*. Halifax, *W. H. H.* (v. v.)

Root a largish disc. *Filaments* densely tufted, 2-6-8 inches long (in my American specimens scarcely two inches), capillary, rigid, very dark-green, much branched ; the branches straight and very erect, repeatedly divided, the divisions either alternate or opposite. Penultimate branches often nearly naked, filiform, elongated, very erect and straight ; in luxuriant specimens set throughout with opposite or fascicled or scattered subulate ramuli, whose terminal cell is sometimes acute, sometimes obtuse. The process of cell division is well illustrated in this species, and may be observed even in dried specimens, so perfectly does the endochrome recover its form. The cells of the middle portion of the branches divide as well as those of the younger ramuli, and consequently consecutive cells are found of various lengths.

Two specimens of what I take to be a much denuded and battered state of this species were collected by Dr. Sutherland, in the Arctic expedition under Captain Inglefield, in the above mentioned locality, and have been sent to me by Professor Dickie of Belfast. They are faded to a dull green. The substance and ramification, so far as branches remain unbroken, are those of *C. rupestris* ; but in one specimen the articulations are very short, being only as long as their diameter, or scarcely longer. This peculiarity at first seems sufficiently characteristic of a distinct species, but a little further examination shows that the character is deceptive, resulting merely from the ordinary process of cell-division being in this specimen carried to an excess. On the other specimen are cells of the common length mixed with these short or halved cells ; and intermediate stages occur which quite explain the unusual character of the first specimen.

4. *CLADOPHORA cartilaginea*,* Rupt.; tufts.....? filaments robust, setaceous, elongate, firm, somewhat rigid, rather sparingly branched; branches very erect, scattered, long and virgate, undivided, straight, set with a few scattered, erecto-patent, filiform branchlets, which are either naked or bear one or two minute ramuli; articulations in the older parts much shorter than their diameter; in the younger (towards the ends of the branches) as long, or twice as long as broad. *Rup. Alg. Ochotzk*, p. 211, (403.)

HAB. Unalaschka, *Dr. Ruprecht*. (v. s. in Herb. T.C.D.)

My only specimen is a fragment, but it seems to belong to a well characterised species of large size. The portion before me is about four inches long, with a few lateral virgate branches, set at very acute angles, quite simple, straight and three inches long, furnished with several scattered, simple, erect ramuli, each of them from half an inch to an inch in length, obtuse, nearly as thick as the stem from which they spring. These are mostly naked, but in a few cases they bear a minute ramulus near the tip. The apices are not attenuated. The diameter of the filament is equal to that of hogs' bristle. The substance is firm and cartilaginous, and the colour a pale-green. Through the greater part of the filament the articulations are much shorter than their diameter; but towards the apices they are longer, and the few terminal joints are twice as long as broad, or more.

*** ARCTÆ. Filaments soft, forming dense, spongy, fastigate tufts of a pale, but vivid green.

5. *CLADOPHORA arcta*, Dillw.; tufts dense, more or less matted at the base, starry, fastigate, soft, brilliant and glossy green; filaments capillary, much branched; branches straight, crowded, very erect; ramuli opposite or scattered, erect or appressed; articulations in the lower part of the frond about twice as long as broad, in the upper (younger) branches many times longer than the diameter; apices obtuse. *Dillw. Conf. Supp.* p. 67, t. E. *E. Bot.* t. 2098. *Harv. Phyc. Brit.* t. 135. *C. arcta*, *vaucheriaeformis*, and *centralis*, Auct. *C. scopæformis*, *Rup.*

HAB. Coasts, from the Arctic Regions to New York Bay, on rocks near low water mark. Whalefish Islands, Davis's Straits, *Dr. Lyall*. Prince Edward's Island, *Dr. Jeans*. Penobscot Bay, *Dr. Young*. Boston Harbour, *Mr. G. B. Emerson*. New York Bay, *Messrs. Walters, &c.*, *W. H. H.* (v. v.)

* Besides this species *Dr. Ruprecht* notices the following from Russian America:—*C. adhærens*, *Rup.* from the Arctic Sea, allied to *C. arcta* (if it be different); *C. Chamissonis*, *Rup.* from Unalaschka; *C. Mertensii*, *R.* from Sitcha; *C. viminea*, *Rup.* from Sitcha and Unalaschka; *C. scopæformis*, and *C. coalita*, from Northern California. Of these *Dr. Ruprecht* has sent me fragments of *C. Chamissonis*, *C. viminea*, and *C. coalita*; but as he has not, that I am aware of, assigned full specific diagnoses to any of the above species, I am unwilling to describe the few that I possess, from the very imperfect materials at my command, lest I might add to the confusion already sufficiently confounded in this genus. I collect the above names from *Dr. Ruprecht's Alg. Ochotsk.*, as already quoted.

This species varies much in minor characters, but may generally be known by its lubricous substance, brilliant colour, fastigate tufts, and straight, much branched filaments which radiate to every side from a common base, in a star-like manner. In the young plant the tufts are less dense, the filaments nearly free from each other to the very base; but as the plant advances in age, root-like processes are developed along the lower part of the filaments, while the tufts become matted together, sometimes into a compact spongy frond. In very old specimens this condensation takes place throughout the whole length of the filament, except in the very youngest ramuli. The tufts are from two to four inches in height, hemispherical, or variously divided into two or more hemispherical or flabelliform lobes, and are generally level-topped. They are composed of many parallel, much branched, capillary filaments, of nearly equal diameter from base to apex; the branches all very straight and erect, repeatedly but most irregularly divided, and set with lateral, erect, straight ramuli, which are nearly as robust as the branches from which they spring, and very obtuse. Toward the base of the filaments the articulations are once or twice as long as broad; a little farther up they are three to four times; and in the young branches and ramuli six to eight or twelve times as long as broad. In the state or variety called *C. centralis* they are uniformly short throughout except in the very young tips. The endochrome is dense and granular, and recovers its form on being moistened after having been dried. The colour in general is well preserved in drying, in which state the tufts retain much of their gloss, and closely adhere to paper.

Authors have made several species out of what we regard as simply *C. arcta* in different stages. Thus *C. vaucheriæformis* is the young, half-developed form; *C. arcta*, Auct. the middle stage; and *C. centralis* the old plant, where the matting together of the threads has been carried to an extreme point. Other species of Kützing's section *Spongomorpha* might probably be added to these synonyms. A fragment of *C. scopæformis*, Rup. from Russian America, sent to me by Dr. Ruprecht himself seems to belong to one of the spongy forms of this species. *C. arcta* is perennial; and specimens collected in the same locality at different seasons will be found to put on, successively, all the characters attributed to the three principal forms indicated above.

6. *CLADOPHORA lanosa*, Roth.; tufts dense, globose, small, fastigate, yellow-green; filaments slender, irregularly much branched; branches straight and virgate, erect, patent; ramuli few, scattered, erect, straight; axils acute; articulations in the lower part twice, in the upper six to eight times as long as broad. *Roth. Cat. Bot.* 3, p. 291, t. 9. *E. Bot.* t. 2099. *Lyngb. Hyd. Dan.* t. 56. *Kütz. Sp. Alg.* p. 420. *Harv. Phyc. Brit.* t. 6. *Wyatt, Alg. Danm.* 194.

HAB. On the smaller Algæ, and on *Zostera*; generally epiphytic. Boston Bay, *Mr. G. B. Emerson.* (v. v.)

Tufts rarely more than an inch in diameter, globose, dense, formed of many filaments radiating from a common base. These filaments are at first separate, but at length by means of rooting processes issuing along their sides, they become somewhat interwoven

below. They are fastigiate and very irregularly divided, but mostly straight, with erect branches and ramuli. The lower articulations are short; the upper, and especially the terminal ones, are very long. The endochrome generally recovers its form after having been dried, at least in the younger portions of the frond, if it have not been discharged, as often happens, by the rupture of the membrane, when the frond is immersed in fresh water. This plant adheres closely to paper.

A much smaller species than *C. arcta*, to which, as well as to *C. uncialis*, it is nearly allied.

7. *CLADOPHORA uncialis*, Fl. Dan.; tufts short, vivid-green, very dense, spongy, globose, simple or somewhat lobed, fastigiate, composed of numerous filaments matted together by lateral rootlets; filaments flexuous, sparingly branched, interwoven; branches and ramuli distant, patent, curved, alternate or secund; articulations of uniform length, about twice as long as broad. *Fl. Dan. t. 771, fig. 1. Lyngb. Hyd. Dan. t. 56. Ag. Syst. p. 111. Wyatt, Alg. Danm. 146. Harv. Phyc. Brit. t. 207. Kütz. Sp. Alg. p. 420.*

HAB. On rocks near low water mark. Prince Edward's Island, *Dr. Jeans*. Halifax, *W. H. H. Nahant, Mrs. Mudge.* (v. v.)

Tufts about an inch in height and diameter, very dense and spongy, either somewhat globose, or cleft into numerous spongy divisions, fastigiate. *Filaments* very numerous from a common base, densely matted and interwoven by root-like processes developed along the sides, flexuous, more or less compound. Branches very irregularly disposed, generally distant, secund or alternate, once or twice again divided, and having a few patent, curved, simple ramuli. *Colour*, when growing, a vivid-green; instantly discharged in fresh water, and in drying the specimen fades to a pale yellow-green, especially toward the centre of the tuft. The endochrome recovers its form and fills the cell, on moistening after having been dried. The articulations in all parts of the filaments are of nearly uniform length, twice or thrice as long as their diameter. *Substance* soft but not gelatinous.

Very nearly related to *C. lanosa*, but the place of growth is different, and the filaments are more flexuous, the branches more patent, and the rooting processes more numerous.

**** GRACILES. Filaments loosely tufted, feathery, very slender, pale or bright-green.

8. *CLADOPHORA glaucescens*, Griff.; filaments loosely tufted, pale or glaucous green, very slender, flexuous, excessively branched; branches erecto-patent, flexuous, repeatedly sub-divided, the penultimate ones pectinated with closely set, elongate, straight, slender, many celled, erect or sub-erect ramuli; axils acute; articulations constricted at the nodes, nearly uniformly thrice as long as broad, those of the main branches a little the longest. *Wyatt, Alg. Danm. No. 195. Harv. Phyc. Brit. t. 196. Kütz. Sp.*

Alg. p. 403. *Var. β. pectinella*; small, very slender, all the divisions of the ramification secund, the penultimate ramifications closely pectinated with short ramuli and recurved.

HAB. On rocks and stones, between tide marks and in rock pools. Halifax, *W. H. H. Lynn* and *Nahant*, *Mrs. Mudge*. Portsmouth, N. H., *Dr. Durkee*. New York Bay, *Messrs. Hooper, Calverley, Walters, and Pike*. Beesley's Point, Rhode Island, *Mr. Ashmead*. *Var. β.* Charleston, S. C., *Prof. L. Gibbes, W. H. H.* (v. v.)

Filaments very slender, 3–5 inches long, forming tufts of greater or less density, but not usually entangled or interwoven, excessively branched, the main divisions and principal branches flexuous, sometimes very much so, closely beset with lesser branches which divide either alternately or secundly, the tendency to secund ramification increasing as the frond extends. The penultimate branchlets are generally closely pectinated with secund, erect, straight, simple ramuli composed of several cells; and occasionally the ramuli are fascicled, three or four springing from the same cell. Though always very slender, the diameter varies. The articulations, on the whole, are pretty uniform; those of the ramuli are most constricted at the nodes, and also a little the shortest. In drying the endochrome is dissipated from the centre of the cell, and collapsed at the two ends, so that the filaments, in dried specimens, have a variegated appearance under a pocket lens. On remoistening, it never perfectly recovers its form.

My Halifax specimens are identical with those published by *Mrs. Wyatt*, and on which the species was originally founded. Those from other localities vary in some degree, being either coarser or more slender, and more or less branched; but on the British coasts similar varieties occur.

9. *CLADOPHORA flexuosa*, Griff.; filaments very slender, pale green, tufted, flexuous, sparingly and distantly branched; branches elongate, sub-simple, of unequal length, flexuous, sometimes nearly naked, sometimes ramuliferous; the ultimate ramuli secund or alternate, short or long, curved; articulations of the branches 3–4 times, of the ramuli twice as long as broad. *Griff. in Wyatt, Alg. Danm. No. 227. Harv. Phyc. Brit. t. 353.*

HAB. Rock pools between tide marks, &c. Hingham, Massachusetts, *Miss Brewer*. Boston, *Dr. Durkee*. Jackson Ferry and Hell Gate, New York, *Messrs. Walters and Pike*. (v. s.)

Very nearly related to *C. glaucescens*, if really specifically distinct. It is chiefly known by its less compound habit, the length and nakedness of the principal branches, and their flexuosity. The diameter of the filament is nearly as in *C. glaucescens*: the articulations are rather longer. Some of the specimens are nearly destitute of ramuli, and scarcely two of those before us agree in all respects.

10. *CLADOPHORA Morrisia*; tufts elongate, dense, somewhat interwoven, dark green;

filaments very slender, much and irregularly branched, the penultimate branches very long, filiform, flexuous, simple, set with alternate or secund, short, erecto-patent ramuli, some of which are simple and spine-like, others pectinated on their upper side ; articulations filled with dense endochrome, in the branches 2-3 times, in the ramuli about twice as long as broad, cylindrical, not contracted at the nodes. (TAB. XLV. B.)

HAB. Elsinborough, Delaware, *Miss E. C. Morris*. (v. s. in Herb. T.C.D.)

Tufts dense, 6-8 inches in length. *Filaments* inextricably bundled together, very slender, much branched, the ramification of the principal divisions not determinable from dried specimens. The penultimate branches which float out from the somewhat rope-like tufts are generally simple for an inch or two in length, or the longer ones are furnished with similar simple branches ; and all are beset with short, erecto-patent ramuli. Some of the ramuli are simple, of 3-4 cells ; others emit similar ramuli on their upper side. The membrane of the cell-wall is very thick and tough, and the endochrome peculiarly firm, recovering its form well on being moistened after having been dried. The nodes are not contracted, and the internodes or articulations rarely exceed thrice their diameter in length, and often do not reach that dimension. The colour is a full dark-green, somewhat olivaceous when dried. Specimens adhere closely to paper.

I have as yet only received this plant from Miss Morris. It differs in several respects from any that I now remember.

PLATE XLV. B. CLADOPHORA *Morrisiæ* ; *Fig. 1*, the *natural* size. *Fig. 3*, portion of a branch : and *Fig. 2*, a ramulus of the same ; *magnified*.

1. CLADOPHORA *refracta*, Roth. ; filaments very slender, rather densely tufted, bright green, membranaceous (not lubricous), excessively branched ; secondary branches spreading on all sides, repeatedly divided and very patent, densely set with short, often opposite, recurved or squarrose branchlets, which are pectinate on the inner face with patent, simple or forked ramuli ; articulations of the branches 2-4 times of the ramuli about twice as long as broad. *Roth. Cat.* 2, p. 193. *Alg. Syst.* p. 114. *Wyatt, Alg. Danm. No.* 228. *Harv. Phyc. Brit. t.* 24. *Kütz. Sp. Alg.* p. 398.

HAB. On rocky coasts, in tide pools, &c. Rhode Island, *Mr. Olney*, *Mr. G. Hunt*. Boston Bay, *Dr. A. Gray*. Portsmouth, N. H., *Dr. Durkee*. New York, *Messrs. Calverley, Walters, and Pike*. Newport, R. I., *Professor Bailey*. Seaconot, *Mr. Congdon*. Charleston, S. C., *Professor Gibbs*. (v. v.)

Tufts 2-3 inches long, feathery, rather diffuse, the main filaments sometimes interlaced in rope-like bundles. *Filaments* more slender than human hair, rather rigid, tough, excessively branched, all the divisions patent or divaricate. The penultimate ramuli are especially reflexed or refracted, and often opposite ; their ultimate divisions are

either simple or forked. The colour is a brilliant green, but it does not well preserve in drying, in which state the specimen is without gloss and generally pale. The endochrome is generally dissipated in drying, and does not, in ordinary cases, recover its form when the frond is remoistened; sometimes, however, the endochrome remains.

A beautiful species, and tolerably easily known. The American specimens are very similar to our West of Ireland plant, but more robust than those from the South Coast of England.

12. *CLADOPHORA albida*, Huds.; filaments exceedingly slender, flaccid, but not gelatinous, pale green, forming dense, silky or somewhat spongy, soft, intricate tufts, very much branched; branches zigzag, their divisions very patent, the lesser branches very frequently opposite, and nearly horizontal; ramuli alternate, opposite or secund, patent or divaricating; articulations 3-5 times as long as broad. *Huds. Fl. Angl. p. 595. E. Bot. t. 2327. Wyatt, Alg. Danm. No. 96. Harv. Phyc. Brit. t. 275.*

HAB. On rocks and algæ, between tide marks. Staten Island, *Dr. Torrey*. Beesley's Point, *Mr. Ashmead* (64, 65, 66). New York Bay, *Messrs. Calverley, Walters, &c.* (v. v.)

Tufts 6-8 inches long, very dense and soft, and somewhat intricate or woven together, occasionally feathering and opening out freely. *Filaments* excessively slender and very much branched, and so interwoven that it is impossible to trace the branching. In the American specimens the main branches are very flexuous, angularly bent from side to side, and very much divided, all the divisions squarrose or divaricating. The penultimate branches, which are nearly horizontally patent, are generally opposite, but three or more sometimes issue from the same point; the ultimate ramuli are scattered, either alternate or secund. The nodes are somewhat contracted; the cell-wall thin, and the endochrome pale and watery. When dry the whole plant frequently becomes a dull greenish white. It does not strongly adhere to paper.

13. *CLADOPHORA Rudolphiana*, Ag.; filaments very long, exceedingly slender, flexuous, sub-gelatinous, much branched, bright yellow-green, inextricable; branches di-trichotomous or irregular; ultimate ramuli pectinate, secund, very long, and much attenuated; articulations of the main branches many times longer than broad, here and there swollen, their granular endochrome somewhat spiral; those of the ramuli 6-10 times as long as broad. *Ag. Bot. Zeit. 10, p. 636. Harv. Phyc. Brit. t. 86. Kütz. Sp. Alg. p. 404.*

HAB. Jackson Ferry, N.Y., *Mr. Walters.* (v. v.)

A specimen sent by *Mr. Walters* agrees pretty well with the Irish specimens figured in *Phyc. Brit.* The filaments are 4-5 inches long, soft, and somewhat gelatinous, closely adhering to paper, intricately interbranched, very flexuous, zigzag, and much branched. The branches are patent, sometimes opposite, mostly alternate or scattered,

and repeatedly divided ; the ramuli slender, few and subdistant. The articulations of the branches are very many times longer than broad ; those of the ramuli 5–6 times their breadth. The endochrome is generally dissipated in drying. When dry the specimen retains a brilliant green and has a silky gloss.

14. *CLADOPHORA gracilis*, Griff.; filaments very long, capillary, flexuous, silky, much branched, bright yellow-green ; main branches entangled, sparingly divided, angularly bent ; ultimate ramuli pectinate, secund, much attenuated, straight, and very long ; articulations 3–5 times as long as broad. *Griff. in Wyatt, Alg. Danm. No. 97. Harv. Phyc. Brit. t. 18. Kütz. Sp. Alg. p. 403.*

HAB. Growing on *Zostera*, and the various Algæ, in the Laminarian zone. Nahant, *Mrs. Mudge*. Beesley's Point, Rhode Island, *Mr. Ashmead* (67.) Seaconot, Rhode Island, *Mr. Olney*. (v. v.)

Filaments more or less densely tufted, 4–12 inches long, (about 4 inches in the American specimens), capillary, soft and silky, much branched ; the main branches rather more robust and bent in a zigzag manner, sometimes very flexuous, and frequently more strongly coloured than the rest of the plant, set throughout with lateral, decompound branches all whose divisions are patent ; and the ultimate branchlets pectinated with long, simple, secund ramuli. *Colour* a yellow-green. *Substance* soft and silky, but not gelatinous. *Articulations* 3–5 times as long as broad. It does not strongly adhere to paper in drying.

Mrs. Mudge's specimens are small, but in other respects very similar to English ones. Those from *Mr. Olney* and *Mr. Ashmead* are less true to the type.

15. *CLADOPHORA brachyclados*, Mont.; filaments very slender, tufted, sparingly branched ; branches long and virgate, set with distant, alternate, erecto-patent branchlets, which are pectinated along their upper sides with very short, erect, or incurved ramuli, of 1 or 2 cells ; articulations of the branches 5–6 times as long as broad. *Mont. Cuba, p. 13, t. 4. Sylloge Pl. Crypt. p. 456. C. Montagneana, Kütz. Tab. Phyc. vol. 4, p. 9, t. 41, fig. 2.*

HAB. Mouth of Rio Bravo, on the sea-beach, *Dr. Schott*. (v. s. in Herb. T.C.D.)

The specimen received from *Dr. Schott* is a very imperfect one, but its filaments, when examined under the microscope, show so many characters in common with those of *Montagne's C. brachyclados* from Cuba, with an authentic specimen of which I have compared them, that I am unwilling to separate forms so similar. The short, mostly single-celled ramuli are characteristic.

16. *CLADOPHORA luteola*; filaments very pale yellow-green, tufted, excessively slender,

and much branched, not matted together; main and lesser branches remarkably flexuous, the angles rounded, and the filaments arcuate; branching irregular, frequently trichotomous, the lesser ramuli secund or opposite, and their ultimate divisions pectinate, somewhat corymbose and crowded toward the apices; articulations cylindrical, hyaline, 6-8 times as long as broad.

HAB. Growing on littoral corals, at Key West, *W. H. H.* (v. v.)

Filaments 2-3 inches long, rather loosely tufted, excessively slender, and soft, but not in the least gelatinous, very much branched, remarkably bent; the filaments arcuate between each ramification. The branching is irregular. In the principal and also in the lesser divisions it is frequently trichotomous, three branches springing from a node; but the branches are almost as often alternate or sub-dichotomous. In the medial portion of the frond the forkings are sub-distant; they become more frequent upwards, and the branches generally end in closely set, but scarcely fasciculate pectinated ramuli, which are either opposite, alternate, or secund. The ultimate ramuli are erect and incurved. *Articulations* seldom less than six times as long as broad, sometimes more, with a very pale, watery endochrome, which is dissipated in drying. Notwithstanding its tenuity this plant does not adhere closely to paper.

***** *LÆTEVIRENTES.* *Filaments* loosely tufted, robust, and somewhat firm or rigid, vivid-green.

17. *CLADOPHORA lætevirens*, Dillw.; filaments much branched, bushy, forming tufts of a transparent, yellow-green colour (faded and without gloss when dry); branches erecto-patent, crowded, repeatedly divided, flexuous, the lesser divisions often opposite, ultimate ramuli secund, blunt, of few articulations; articulations of the branches six times, of the ramuli thrice as long as broad. *Dillw. Conf. t.* 48. *E. Bot. t.* 1854. *Harv. Phyc. Brit. t.* 190. *Wyatt, Alg. Danm. No.* 143. *Kütz. Sp. Alg. p.* 400. *Conf. glomerata var. marina*, *Roth. Cat. Bot.* 3, p. 237.

HAB. In rock pools between tide marks. New York Bay, *Messrs. Hooper & Walters*. Boston, *Dr. Durkee*. California, *Dr. Coulter*. (v. v.)

Tufts feathery. *Filaments* 3-6 inches long or more, capillary, much branched, main filaments flexuous or angularly bent, set with alternate or scattered, occasionally opposite, repeatedly decompound patent branches, which are densely set with lesser branches and ramuli, all of which are patent and often recurved. Lesser and penultimate branches mostly secund, sometimes opposite or fasciculate, their ultimate divisions pectinated with short closely set ramuli on the upper side. Articulations of the main branches 4-6 or 8 times, of the ramuli 3-4 times as long as broad. *Colour*, a full grass green. *Substance*, not very soft. It adheres, but not strongly, to paper in drying.

18. *CLADOPHORA diffusa* (?); filaments capillary, elongate, loosely tufted, somewhat rigid, full green, flexuous, much branched; branches distant, irregularly subdivided, nearly naked, or furnished toward the ends with a few short secund ramuli; articulations 3-4 times as long as broad. *Harv. Phyc. Brit. t. 130* (?) &c.

HAB. New York Sound, *Messrs. Walters, Pike, &c.* California, *Mr. A. D. Frye.* (v. s.)

Tufts loose. *Filaments* 6-12 inches long or more, generally so rigid as not to collapse when removed from the water, capillary or somewhat more robust, much and irregularly branched. Branches distant, often an inch or more apart, erecto-patent, naked in the lower portion or very sparingly ramulose, and sometimes naked throughout and little subdivided. Generally, however, the upper divisions are more repeatedly and more closely branched, and their branches furnished with a few short, secund, pectinate ramuli. On some specimens these are very few and confined to the apices; on others they are more abundant.

Recognised chiefly by its naked and distant branches, nearly destitute of ramuli. The more ramulose specimens seem gradually to glide off into *C. lætevirens*. I quote the figure in *Phyc. Brit.* with a mark of doubt, and refrain from quoting other authorities, because I am not quite sure of the specific identity of the American and European specimens.

SECT. 2. Species found in brackish water, or in fresh-water ponds and streams.

19. *CLADOPHORA fracta*, Fl. Dan.; tufts irregular, entangled, often detached and then forming floating strata, dull green; filaments rather rigid, distantly branched, the lesser branches somewhat dichotomous, spreading, with very wide axils; the ramuli few, alternate or secund; articulations 3-6 times as long as broad, at first cylindrical, then elliptical, with contracted nodes. *Fl. Dan. t. 946.* *Dillw. Conf. t. 14.* *E. Bot. t. 2338.* *Lyngb. Hyd. Dan. t. 52.* *Harv. Phyc. Brit. t. 294.* *Kütz. Sp. Alg. p. 410.*

HAB. In salt water ditches and ponds, also in brackish or fresh water. Rhode Island, and in the Hudson, at West Point, *Prof. Bailey.* Beesley's Point, *Mr. Ashmead.* Near New York, *Mr. Walters.* (v. v.)

This is at first tufted and attached to sticks or stones, but afterwards occurs floating, and then forms strata of considerable extent. *Filaments* capillary, several inches long, loosely tufted or bundled together, much but distantly branched, the branches widely spreading at very obtuse angles, and again and again dividing, all the minor divisions being equally patent, and the angles equally wide. The lesser branches sometimes bear a few secund ramuli, and are sometimes quite naked. *Colour*, at first a grass green, but gradually becoming darker. *Substance*, membranaceous and rather rigid, seldom quite adhering to paper in drying, and readily detached.

To this species I am disposed to refer a specimen which was provisionally named *C. prasina*, formerly received from Professor Bailey, who found it abundantly in the Hudson at West Point, where it is thrown ashore after storms. I have also received a fresh-water specimen collected by Dr. Bigelow when engaged on Lieutenant Whipple's expedition to the Pacific.

20. *CLADOPHORA glomerata*, Linn. ; filaments tufted, bushy, somewhat rigid, much branched, bright grass-green ; branches crowded, irregular, erecto-patent, repeatedly divided ; ultimate ramuli secund, subfasciculate ; articulations 4--8 times as long as broad. *Dillw. Conf. t. 13. E. Bot. t. 2192. Harv. Man. Ed. 1, p. 134.*

HAB. In streams, lakes, and rivers. Probably common.

I have received North American specimens from Milton, Saratoga County, N.Y., and from Lake Erie ; also from the Mexican Boundary Surveying Expedition.

IV. CHÆTOMORPHA, Kütz. (May, 1845.)

Filaments (not gelatinous), membranaceous or cartilaginous, unbranched, attached, or floating, articulated ; formed of a string of oblong cells, the basal cell longer than the rest. *Articulations* filled with granular endochrome. (*Marine.*)

The genus, as here adopted from Kützing, is intended to include most of the marine species of the older *Conferva*, which have unbranched filaments and articulations usually longer than their diameter. It differs from *Cladophora* solely in being branchless. From *Hormotrichum* it is less easy to point out a clear distinctive character, unless we seek it in the substance of the cell-coats, and in the shortness of the cells usual in that genus. The name *Aplonema* was proposed for this group by Mr. Hassall (*Brit. Fr. W. Conf. p. 213.*) only two months subsequently to the publication of Kützing's genus, which thus establishes its priority on very narrow evidence. It forms a part of the Agardhian *Lychnæte*, published in 1846 ; a group that includes both simple and branched species, and which is thus characterised by its author :—

LYCHNÆTE, J. Ag. ; “fronde sub-heterogenea, articulo infimo (in simplicibus), aut infimis ramorum (in ramosis) dissimilibus et non mutandis, superioribus omnibus continua subdivisione iterum iterumque divisis atque coniocystis externis distinguendum.” *Alg. Ined. Ed. 2, No. 9. (Lychnæte mirabilis).*

I prefer, with Kützing, to keep the branching and unbranched species in separate genera, as being a more obvious, if not more natural arrangement. However, the whole subject of the natural arrangement of these obscure plants is open to future discussion. The present is but a temporary settlement of the question.

1. *CHÆTOMORPHA Piquotiana*, Mont. ; filaments loosely bundled together in strata, very long, ultra-setaceous, grass-green, rigid, glossy and variagated when dry, variously twisted ; articulations 3-5 times as long as broad, contracted at the nodes. *Mont. An. Sc. Nat. 3d Ser. vol. 11, p. 66.* *Mont. Syll. p. 459.* *Kütz. Sp. Alg. p. 379.* *Tab. Phyc. vol. 3, p. 19, t. 58, f. 2.* (TAB. XLVI. C.)

HAB. In deep water ; from 5 to 6 fathoms. Coast of Labrador, *M. Lamare-Piquot!* Burnt Coat Island, Maine, *Dr. A. Young.* Halifax, *W. H. H.* Boston Bay, *Mrs. A. Gray.* Staten Island, N.Y., *Dr. Torrey.* (v. v.)

This occurs in large bundled strata, the filaments lying loosely together, but probably they are attached at an early age. *Filaments* 12-14 inches long or more, twice as thick as hog's bristle, crisp and rigid, variously curved and twisted, of a full grass-green colour, fading in drying, but retaining a glossy surface. The *endochrome*, in drying, is usually dispersed toward the ends of the cell, which gives the filament a variegated look, with alternate pale and dark bands. The cell membrane is thick and tough. The articulations are variable in length, but always much longer in proportion than those of *C. melagonium*. They are commonly four times as long as broad ; occasionally only thrice their breadth, and sometimes 5-6 times as long. The dissepiments or nodes are always much constricted and very narrow. The endochrome recovers its form when remoistened. It does not adhere to paper.

I have compared my specimens with an original one communicated by Dr. Montagne. The species is nearly related to *C. melagonium*, but of larger dimensions and with much longer articulations.

PLATE XLVI. *Fig. 1.* *CHÆTOMORPHA Piquotiana*, the *natural* size. *Fig. 2,* a magnified portion.

2. *CHÆTOMORPHA melagonium*, Web. and Mohr. ; root scutate ; filaments erect, straight, elongate, very robust, ultra-setaceous, stiff and wiry, dark-green, tapering to the base, obtuse ; articulations 2-3 times as long as broad. *Ag. Syst. p. 99.* *Lyngb. Hyd. Dan. t. 51.* *Harv. Phyc. Brit. t. 99.* *A. Wyatt, Alg. Danm. No. 221.* *Kütz. Sp. Alg. p. 379.*

HAB. In rock pools near low water mark, and at a greater depth. Greenland, *Wormskiöld.* Halifax, *W. H. H.* Boston Bay, *Mrs. Asa Gray.* Newbury Port, *Mr. Hooper.* Unalaschka, *Wosnessensky.* (v. v.)

Root an expanded disc. *Filaments* either scattered, or somewhat tufted, 5-12 inches long, twice as thick as hog's bristle, erect and stiff, peculiarly wiry to the feel when growing, straight or slightly curved, very blunt at the apex, and tapering to the base. *Articulations* rather longer in the American than in European specimens, but variable even in the same tuft ; once and a-half, twice, or thrice as long as broad, filled with dark-green endochrome and contracted at the dissepiments.

3 *CHÆTOMORPHA ærea*, Dillw. ; root scutate ; filaments setaceous, tufted, straight, (sometimes twisted in age) harsh and brittle, yellow-green ; articulations about as long as broad. *Dillw. Conf. t.* 80. *E. Bot. t.* 1929. *Lynb. Hyd. Dan. t.* 51. *Ag. Syst. p.* 100. *Wyatt, Alg. Danm. No.* 191. *Harv. Phyc. Brit. t.* 99. *B. Kütz. Sp. Alg. p.* 379.

HAB. In rock pools, between tide marks, &c. Newport, *Professor Bailey*. New York Bay, *Messrs. Hooper, Walters, &c.* (v. v.)

Filaments generally in dense tufts, 3-12 inches in length, and as thick as hog's bristle, rather harsh to the touch when fresh, but much less rigid than *C. melagonium*, and collapsing on being removed from the water, usually straight, but old specimens are sometimes crisped and contorted. The colour when growing is a beautiful yellowish green, but dried specimens are usually much faded, and dull-greenish white after long keeping in the Herbarium. The endochrome fills the cell and is of a watery consistence, and dispersed in drying. The articulations are pretty uniformly as long as broad, with contracted dissepiments.

4. *CHÆTOMORPHA Olneyi*, Harv. ; filaments tufted, setaceous, straight or curved, soft, pale-green ; articulations once and half as long as broad. (TAB. XLVI. D.)

HAB. Rhode Island, *Mr. Olney*. (v. s. in Herb. T.C.D.)

This has the habit of *C. ærea*, but is of a soft and flaccid substance, adhering closely to paper in drying. When dry it is very pale, greenish white, and without gloss. The filaments are about the same diameter as those of *C. ærea* ; the articulations are longer, and the cell-wall thicker.

PLATE XLVI. D. Fig. 1. *CHÆTOMORPHA Olneyi*, the natural size. Fig. 2. a portion magnified.

5. *CHÆTOMORPHA longiarticulata*, Harv. ; filaments capillary, curved, loosely bundled together, flaccid, soft, pale green ; articulations 4-6 times as long as broad, swollen at the nodes. (Tab. XLVI. E.) Var. β . *crassior* ; filaments more robust.

HAB. In rock pools, between tide marks. Ship Anne Point, *Mr. Hooper*. Boston Bay, *Mrs. Asa Gray*. Little Compton, *Mr. Olney*. Var. β , in brackish ditches at Little Compton, *Mr. Olney*.

Filaments rather more slender than human hair, 3-4 inches long, loosely bundled together, and somewhat stratified. *Articulations* filled with very pale endochrome, almost hyaline when dry, several times longer than their diameter, nodoso-incrassate at one or both ends, with contracted dissepiments. The cell-wall is very thin and membranous.

I do not know any species to which this is nearly related. It is much more robust than *C. arenosa*. The length of the joints and the swelling of the nodes distinguish it from *C. litorea*.

PLATE XLVI. E. *Fig. 1.* CHÆTOMORPHA *longiarticulata*; the natural size. *Fig. 2,* a portion *magnified.*

6. CHÆTOMORPHA *sutoria*, Berk. ; filaments setaceous, elongate, flexuous, equal, pale or dark green ; articulations once and half as long as broad ; interstices pellucid. *Berk. Gl. Alg. t. 14, f. 3. Harv. Phyc. Brit. t. 150. B. Ch. rigida, Kütz. Sp. Alg. p. 377.*

HAB. Floating in large masses at Stonington, Con., *Prof. Bailey.* (v. s.)

This occurs, loosely bundled together in extensive floating masses or strata. *Filaments* as thick as hog's bristle, several inches long, rigid and variously curved and twisted, pale-green, cylindrical. *Articulations* once and half as long as broad, at length bisected. *Substance* rigid. It scarcely adheres to paper in drying.

Professor Bailey's specimens chiefly differ from the British plant with which I have associated them in being of a paler colour, with less dense endochrome, and of rather softer substance.

7. CHÆTOMORPHA *litorea*, Harv. ; filaments capillary, rigid, crisp, forming loose, extensive, dull-green bundles ; articulations once and half as long as broad, here and there swollen in pairs and discoloured. *Harv. Phyc. Brit. t. 333. C. linum, Alg. Danm. No. 220 (Excl. Syn.) C. tortuosa, var. crassior, Rup. Alg. Och.*

HAB. Sea-shores. Sitcha, Russian America, *Wosnessensky.* (v. s.)

Filaments forming loosely interwoven, extensive, floating strata, or entangled among the branches of other Algæ, capillary, several inches in length, and of a dull green colour. The articulations are once and a-half to twice as long as broad, cylindrical, not contracted at the nodes, and mostly uniform in the same filament ; but here and there a pair of longer cells occur, which are swollen towards their commissure, where the endochrome collects in a dark mass. In drying the endochrome is usually dispersed, and never recovers its form on being moistened.

This has been sent to me by Dr. Ruprecht from Sitcha, under the name *C. tortuosa, var. crassior*. The filaments, however, are fully twice as robust as in *C. tortuosa* ; they are more rigid, and adhere less strongly to paper, and their endochrome is dissipated in drying. They agree pretty well with the *C. litorea* of British collections.

8. CHÆTOMORPHA *brachygona*, Harv. ; filaments capillary, interwoven in strata, curved and twisted, rigid ; articulations either as long as, or much shorter than their

diameter, with occasionally a pair of swollen longer cells among the short ones. (TAB. XLVI. A.)

HAB. Key West, *W. H. H.*, *Mr. Binney*. Boca di Rio Bravo, *Dr. Schott*. (v. v.)

Forming decumbent strata, covering rocks, or entangled with other Algæ. *Filaments* slender, variously curved and twisted, of a membranaceous, rather rigid substance, destitute of gloss, and not adhering to paper when drying, cylindrical. The articulations appear to be normally about as long as broad, but as they divide in the middle by transverse cell division, they are frequently found less than half their proper length. Here and there, throughout the filament, a pair of cells occur longer than the rest, and swollen, with the endochrome of each cell collected at the dissepiment: these may be connected with reproduction. The endochrome is dispersed in drying, and does not well recover its form on being moistened.

A much more robust and rigid plant than *C. tortuosa*.

PLATE XLVI. A. *Fig. 1.* CHÆTOMORPHA *brachygona*, the natural size. *Fig. 2.* Portion of a filament, *magnified*.

9. CHÆTOMORPHA *tortuosa*, Dillw. ; filaments very slender, somewhat rigid, densely interwoven into dark green, crisped, fleecy strata ; articulations twice or thrice as long as broad, filled with endochrome. *Dillw. Conf. t.* 46. *E. Bot. t.* 2220. *Harv. Phyc. Brit. t.* 54, A. *Ag. Syst. p.* 98. *Kütz. Sp. Alg. p.* 376. (TAB. XLVI. B.)

HAB. On rocks, &c. about half tide level. Halifax, *W. H. H.* Coast of Maine, *Dr. A. Young*. Massachusetts' Bay, *Mr. Pike*, *W. H. H.*, &c. Newbury Port, *Mr. Hooper*. Unalashka, *Wosnessensky*. (v. v.)

Strata spreading widely over the surface of rocks, &c. like a coating of dark green wool. The filaments are very slender, about half the diameter of human hair, but they are when recent crisp and rigid, and do not collapse when removed from the water. They are densely interwoven, of a dark green colour, and not without gloss. The articulations vary in length in different specimens, but are usually twice as long as broad, sometimes more, sometimes less ; and the endochrome generally recovers its form on being remoistened after drying.

I have received from Dr. Ruprecht, under the name *C. confervicola*, a specimen from Unalashka that I cannot distinguish, under the microscope, from the ordinary *C. tortuosa* of the East coast. It grows attached to *C. melagonium*, in which it is peculiar. The "*C. tortuosa crassior*" of Dr. Ruprecht I have already alluded to under *C. litorea*.

PLATE XLVI. B. *Fig. 1,* CHÆTOMORPHA *tortuosa*, the natural size. *Fig. 2,* portion of two filaments, *magnified*.

V. HORMOTRICHUM, Kütz.

Filaments gelatino-membranaceous, unbranched (or with a few rootlike branches), basifixed, articulated ; formed of a string of very short cells. *Cell-wall* very thick and soft. *Nodes* constricted. *Articulations* often tumid, filled with dense, green, granular endochrome, which is finally converted into darker-coloured compact sporidia. (*Marine.*)

The plants comprised under this genus have hitherto been placed either in *Conferva* or in *Lyngbya*. They all have a peculiar habit, by which they are more readily known than by any definite character at present established. The changes that take place in the endochrome will probably afford better characters when they have been carefully ascertained and compared with what occur in *Chaetomorpha*. At present we are contented to refer to this place all the soft, sub-gelatinous, marine Confervæ, which are basifixed, and have short joints—the type of these being *C. Youngana*, Dillw. ; and such *Lyngbya*-like Algæ as *Lyngb. Carnichaelii* and its allies, whose truly articulated tube distinguishes them from proper *Lyngbya*. The whole assemblage of species which are thus brought together are remarkable for the brilliant green of their endochrome, which at first fills the cells, and is afterwards contracted and condensed, and for the breadth of the soft, sub-gelatinous, glassy cell-wall. At maturity the wall of the cell opens, and the compact *sporidium* escapes. All the species are natives of littoral rocks and objects growing within tide marks. Three of the following are European.

1. HORMOTRICHUM *Younganum*, Dillw. ; filaments short or elongated, tufted, capillary, rather firm, grass-green, not remarkably gelatinous, nor glossy when dry ; articulations as long, or once and half as long as broad, or shorter than their breadth, tumid, constricted at the nodes. *Dillw. Conf. t.* 102. *Harv. Phyc. Brit. t.* 328. *Kütz. Sp. Alg. p.* 382.

HAB. On stones and wood-work, between tide marks. New York Bay, *Mr. Congdon*. Common at Fort Hamilton in spring. *W. H. H.* (v. v.)

Filaments densely tufted, 1–3 inches long, as thick as human hair, erect, straight or curved, spreading over the surface of rocks and wood-work in grass-green fleecy tufts, not lubricous or gelatinous (as compared with others of the genus), soft, but rather firm. The filaments when young are cylindrical, but soon become constricted at the dissepiments or nodes. The cells vary much in length, even in the same filament. The common length is once and half as long as broad, but they are sometimes twice as long, sometimes only as long as their diameter, and sometimes only half as long. At first they are quite filled with the granular deep-green endochrome, which, while the filament is elongating, divides in the centre, forming two new cells from each old one ; but in the mature plant it gradually condenses, and retreats toward the centre of the cell, where it forms a compact, globose or oval sporidium. In drying the filaments adhere, but not strongly, to paper.

2. *HORMOTRICHUM boreale*, Harv. ; filaments slender, forming decumbent strata of a pale yellowish-green, flaccid, slightly interwoven ; articulations as long as broad or somewhat longer, at length constricted at the nodes.

HAB. On rocks near high-water mark. Whalefish Islands, Davis's Straits, *Dr. Lyall*. (v. s. in Herb. T.C.D.)

This forms a thin, yellow-green, decumbent fleece, lying on the surface of the rock, and extending indefinitely. *Filaments* flaccid, glossy when dry, variously interwoven, about half the diameter of those of *H. Younganum*, but in other respects very similar, except that the cells are commonly shorter. *Articulations* usually quadrate ; in age contracted at the nodes.

A much more slender plant than *H. Younganum*, softer, more glossy, and spreading in patches, not tufted.

3. *HORMOTRICHUM speciosum*, Carm. ; filaments long, thick, flaccid, straight, at length curled, the margin slightly crenate, forming bright yellow-green strata, glossy when dry ; articulations half as long as their breadth, the cell-wall very thick. *Harv. Phyc. Brit. t. 186, B. Wyatt, Alg. Danm. No. 196. (Lyngbya.)*

HAB. Mixed with the foregoing species, at Whale-fish Islands, *Dr. Lyall*.

Much more robust than the following species, to which it is allied.

4. *HORMOTRICHUM Carmichaelii*, Harv. ; filaments scarcely capillary, closely interwoven into decumbent, crisped, full-grass-green strata, variously twisted ; articulations half as long as their diameter ; the cell-wall thick. *Harv. Phyc. Brit. t. 186. A. Wyatt, Alg. Danm. No. 230. Kütz. Sp. Alg. p. 382.*

HAB. On rocks and fuci, between tide marks. Near Boston, *Mr. Calverley*. In a "running stream" (quere, of salt, or fresh water ?) on stones, in Wellington Channel, Arctic Regions, *Dr. Lyall*. (v. v.)

Strata extensive, densely interwoven, full green, or somewhat yellowish, soft, but not gelatinous, and not glossy when dry. *Filaments* very long, thinner than human hair, variously curved and twisted. *Articulations* shorter than their diameter, generally less than half as long as their breadth ; the cell-wall thick, and the endochrome at length contracting into a lenticular sporidium.

This plant is common on the British Coasts, where it occurs between tide marks. The specimen received from *Mr. Calverley* is said to come "from fresh water near Boston ;" but I suspect some mistake. Whether that from the Arctic Regions be from brackish or fresh water I cannot tell ; but under the microscope there is no character

by which I can distinguish its threads from British specimens of *C. Carmichaelii*. It is very luxuriant, of a bright green colour, and quite resembles the ordinary marine form. Quere, are two species confounded? Or is there an error in the habitat? Or does this plant inhabit both salt and fresh water, as *Bangia fuscopurpurea* is well known to do?

5. *HORMOTRICHUM?* *Wormskioldii*, Fl. Dan.; filaments "branched at the base" (Lyngb.); thence simple, erect, straight, ultra-setaceous, flaccid, bright yellow-green, moniliform; articulations at first nearly cylindrical and rather longer than broad, then globular, and very much contracted at the nodes. *Conferva Wormskioldii*. Fl. Dan. t. 1547. Lyngb. Hyd. Dan. p. 158. t. 55. A. Ag. Syst. p. 121. *Hormotrichum Wormskioldii*, Kütz. Sp. Alg. p. 383. *Chætomorpha monilis*, Harv. in Herb. (olim.)

HAB. Coast of Greenland, common, *Wormskiold*. Fragments dredged in Queen's Channel, lat. 76° 29', long. 96° 13' W. Dr. Lyall. (v. s.)

Dr. Lyall's specimens, which alone I have seen, consist of a few single threads (broken branches?) 6–8 inches long, as thick as hog's bristle or a little thicker, moniliform, with very turgid globular articulations and strongly contracted dissepiments. These fragments so strongly resemble the figure given by Lyngbye, (t. 55. A. 5.) that I cannot doubt the above reference; but I do question the propriety of arranging this species under the present genus. I follow Kützinger, however, who had probably seen more perfect specimens than I possess. Judging from the fragments collected by Dr. Lyall, I formerly placed it in *Chætomorpha*, near *C. melagonium*, believing that it was an undescribed species.

Lyngbye's description may be thus rendered: "Filaments densely tufted, parallelly floating, an ell or more in length, branched at the base, slender, as thick as human hair (below?), then increasing to the thickness of hog's bristle, or sparrow's quill, simple, attenuated toward the apex. Articulations as long as broad, in the thicker filaments remarkably moniliform, ellipsoidal or globose, turgid; in the more slender filaments often twice as long as broad. Dissepiments contracted, mostly pellucid. Colour green. Substance membranaceous, tender, lubricous, soft. It adheres to paper."

VI. RHIZOCLONIUM, Kütz.

Filaments (not gelatinous) membranaceous, uniform in diameter throughout, decumbent, simple or spuriously branched; branches short and rootlike; formed of a string of oblong cells. *Cell-wall* thin. *Articulations* filled with granular endochrome. (*Marine, or in fresh water, or on damp ground.*)

Confervoid Algæ, forming decumbent strata ; the filaments lying heaped together, and emitting at irregular distances rootlike branches. Kützing enumerates 28 species, among which are several which we refer to *Chætomorpha*.

1. *RHIZOCLONIUM riparium*, Roth. ; filaments long, slender, decumbent, pale-green, forming wide strata, flaccid, entangled, angularly bent, furnished at the angles with short, rootlike processes (which sometimes, but rarely, lengthen into very patent branches, and often attach themselves to neighbouring filaments). *Conf. riparia*, Roth. *Cat. Bot.* 3. p. 216. *E. Bot.* t. 2100. *Dillw. Conf.* p. 111. *Sup. t. E. Ag. Syst.* p. 106. *Harv. Phyc. Brit.* t. 238. *Conf. obtusangula*, Lyngb. *Hyd. Dan.* t. 55. *B. Rhizoclonium obtusangulum*, Kütz. *Sp. Alg.* p. 261.

HAB. On sand covered rocks near high water mark. Greenland, *Wormskiöld*, fide *Lyngbye*. (v. s.)

I have not seen American specimens of this plant.

ORDER VII. ZYGNEMACEÆ.

Zygnemaceæ, Kütz. *Phyc. Gen.* p. 274. *Sp. Alg.* p. 433. *Zygnemecæ*, Endl. 3d *Suppl.* p. 14. *Algæ Synsporeæ*, Dne. *Class.* p. 32. *Conjugatæ*, Berk. *Crypt. Bot.* p. 150. *Conjugateæ*, Hass. *Br. Fr. W. Alg.*, p. 129.

DIAGNOSIS. Green (freshwater) Algæ, consisting of simple, articulated, floating threads, composed of cylindrical, seriated cells. *Endochrome* usually definitely figured. *Spores* of large size, and mostly solitary, formed by the union of two endochromes or by the division of a single endochrome.

NATURAL CHARACTER. Freshwater, floating, *confervoid* Algæ, at first consisting of unbranched threads, formed of a number of cylindrical cells placed end to end ; afterwards often linked together in pairs by connecting processes. The endochrome in different genera puts on a variety of forms. It is rarely diffused equally through the cell as in ordinary *Confervæ*, but is either arranged in spiral bands, attached to the cell-walls, or divided into two star-like masses ; or it consists of larger and smaller grains subsymmetrically arranged. The cell-wall varies also much in character ; in some it is membranous, in others gelatinous, and occasionally very thick. The *fructification* consists of large and mostly solitary *spores* formed usually from the union and condensation of the contents of two cells, either consecutive cells of the same fila-

ment, or cells of different filaments. The latter mode of forming a spore is the most usual, whence we have the origin of the names "*Conjugatæ*" and "*Zygnemæ*" applied to these Algæ, and alluding to their "yoked" character. When two filaments are about to conjugate, they float near one another, lying parallel, or nearly so in the stratum. Then, from the proximate sides of each cell of both filaments there issue short tubes, which mutually unite; the cell-wall at the point of union disappears, and the contents of both cells are mixed together. Sometimes the whole contents of one cell is discharged into the other, and the spore formed in that cell; sometimes, and equally commonly, the spore is formed in the connecting tubes. These tubes are sometimes long and barlike; and the pairs of conjugated threads resemble little ladders. Sometimes they are very short, and the filaments are angularly bent at the point of union. In most cases the spore forms a single spheroidal or angular mass; but in *Thwaitesia* it is divided into four sporules, exactly like the tetraspore of one of the *Rhodospiræ*. In the genus *Edogonium*, which Mr. Berkeley refers to this Family, the filaments do not conjugate, but the spores are formed by a division of the endochrome of a fertile cell. The cell separates into two half-cells by a transverse partition, as in ordinary cell division; the spore is then formed in one half; the other half lengthens to the size proper to the genus and again divides, forming a second spore in one of its halves; and so it may divide repeatedly until a string of six or eight consecutive spores is formed, in the centre or at the end of the thread, as in *Æ. monile*, a beautiful species from Tasmania. The spores are not always green; but (especially in *Edogonium*) are often brilliantly coloured, orange or vermillion.

Several genera, containing a large number of species, are described, chiefly from the stagnant or nearly still waters of the Northern Hemisphere. But they are probably dispersed over the globe, though few have yet been brought from the tropics. Unfortunately they do not recover their characters sufficiently, after having been dried, to admit of being accurately verified from dried specimens: and consequently I am forced to omit specific descriptions of those that I have received from North America. No doubt many of the species of the genera MOUGEOTIA; ZYGNEMA (*Spirogyra*); TYNDARIDEA; STAUROCARPUS; and EDOGONIUM (*Vesiculifera*) exist in American waters; but they must be examined on the spot. Mr. Ravenel has kindly sent me a few specimens of *Staurocarpus* and *Zygnema*, but I have not been able to recognize the species satisfactorily. Authors who have written on the subject appear to me to have needlessly multiplied the European species, of which Kützinger enumerates 200, including 58 *Zygnemata* and as many *Edogonia*.

ORDER VIII.—HYDRODICTYÆ.

HYDRODICTYÆ, *Kütz. Phyc. Gen.* p. 281. *Sp. Alg.* p. 448. *Berk. Crypt. Bot.* p. 138. *Dne. Class.* p. 31. (*in part only.*)

· **DIAGNOSIS.** Green (fresh-water) Algæ, composed of cylindrical cells, united by their ends into a saccate net-work, with polygonal meshes ; each side of the mesh formed of a single cell. *Endochrome* of each cell resolved at maturity into indefinitely numerous, minute *zoospores*, which arrange themselves, end to end, into a new net-work, whilst still contained within the parent cell. *Nets* viviparous.

NATURAL CHARACTER. The genus *Hydrodictyon* differs so remarkably in the mode of evolution of its frond from that of any other confervoid Alga that it has been found necessary to constitute it the type of a distinct family. Its essentially distinctive characters are thus well given by Messrs. Derbes and Soliere in their able memoir : “Each *zoospore* of this plant gives birth to one cell only, whose further development will consist merely in an increase of dimensions, without undergoing any multiplication. Here then, without doubt, is the most distinctive character of the genus ; for in the *Confervæ*, with which it has the greatest affinity, one *zoospore* gives birth to an individual, which increases in dimensions by the multiplication of its cells ; here, on the contrary, a great number of *zoospores* unite together to form an individual, which is composed of a limited number of cells, which number remains the same during the whole duration of the plant ; that is to say, until each of these cellules, in its turn, gives birth to a young *Hydrodictyon* complete. In other terms, a *Hydrodictyon* is an assemblage of little plants reduced to a single cell, formed by the development of a *zoospore*.” If we trace the development, it will be obvious that this is a true explanation of the viviparous net-work.

At all stages of its growth, then, the structure of the *Hydrodictyon* is the same. Young specimens differ from old ones merely in the size of the cells of which the net is composed ; the number of the cells, their form, and that of the net are the same in young as in old nets. In all stages the *Hydrodictyon* is a bag-like or purse-shaped net, with polygonal, generally five-sided meshes, each mesh consisting of a single articulation or cylindrical cell, united by its ends to the neighbouring cells, just as the cells of a *Conferva* are united, but having no passage from cell to cell, and each cell, from first to last, carrying on an independent existence. When first emitted from the

parent, the young *Hydrodictyon* is of microscopic size. It grows rapidly until each articulation becomes from a quarter to half an inch in length, and half a line in diameter. Up to this period the cells are filled with a green semi-fluid endochrome, in which grains of different sizes are formed. Gradually this green matter is resolved into an infinite number of minute zoospores, which are at first spherical, afterwards ovate, pointed at one end; and which, while contained within the cell wall, exhibit lively movements. At length these movements gradually subside, and the zoospores arrange themselves, end to end, into polygonal, commonly pentagonal, areolæ; and when all the zoospores contained within a single articulation have so arranged themselves, the little net is completed before its emission or birth. When all is thus ready, the parent net falls to pieces, each articulation floating separately; and shortly afterwards, on the bursting or deliquescence of the wall of the mother cell, the little network floats independently, and commences its career of growth and development. This curious plant early attracted the notice of botanists, and has deservedly engaged the attention of physiologists. The fullest of the earlier histories is to be found in Vaucher's work on Fresh Water Confervæ; and recent accounts are given by Areschoug in the 16th vol. of "Linnæa;" and by Derbes and Soliere in their memoir presented to the French Academy in 1848. I have never had the opportunity of examining living specimens, though abundantly supplied with dried ones from many distant parts of the world. The only species known inhabits ponds in Europe and in America, both North and South. It is rare in England, and has not yet been found in Ireland.

HYDRODICTYON, Roth.

(Character the same as that of the Order.)

1. *HYDRODICTYON utriculatum*, Roth. *Fl. Germ.* 3. part 1, p. 531. *Fl. Dan.* t. 1597. *Ag. Syst.* p. 84. *Lyngb. Hyd. Dan.* p. 169. t. 58. *Harv. Man. Ed.* 1. p. 140. *Kütz. Phyc. Gen.* p. 281. *Syst. Alg.* p. 448. *Conferva reticulata*, Linn. *Dillw. Conf.* t. 97. *E. Bot.* t. 1687.

HAB. In ponds of fresh water. West Point, *Professor Bailey*. Weehawken, *Mr. Walters*. Waterholes between Van Horn's Wells and Muerte on the Mexican boundary, *Dr. Bigelow*. (v. s. in Herb. T.C.D.)

This has been sufficiently described in the remarks under the Order. The full sized nets are 6-8 or 12 inches long, and 3-4 in diameter; their meshes from half an inch to three quarters of an inch across. In different localities and climates the size varies. No difference is appreciable between American and European specimens.

ORDER IX.—OSCILLATORIACEÆ.

Harv. Man. Ed. 1. p. 219. Oscillatorieæ, Harv. in Mack. Fl. Hib. part 3, p. 164. Endl. 3d. Suppl. p. 12. Oscillatorieæ and Rivularieæ, Harv. Br. Fl. J. Ag. Alg. Medit. p. 8, 10. Oscillatoreæ, Lindl. Veg. Kingd. p. 18. Oscillarieæ, Leptotrichieæ, Lyngbyeæ, Scytonemeæ, Mastichotricheæ, Rivularieæ, Kütz. Sp. Alg. pp. 235-344.

DIAGNOSIS. Green, (rarely olive-brown, blue, or purple) marine or fresh water Algæ, composed of simple or slightly branched filaments; each filament having a membranous unicellular sheath, enclosing an annulated medullary chord of very short cells.

NATURAL CHARACTER. *Root* either a simple point of attachment, or, in most cases, not obvious. *Filaments* of small size, and often very minute, rarely solitary, variously aggregated together. In some microscopic forms, as in *Trichodesmium*, a number of minute filaments lie close together, cohering by their edges and parallel to each other, forming little bundles, resembling *faggots* in miniature; and these float freely in the water, through which they move by a slow, proper motion, rising to the surface or sinking, according to the season. In others, as in *Oscillatoria*, an indefinite number of similar filaments lie loosely in a gelatinous matrix, within which they are developed, and from the edges of which they radiate; but they have no definite or determinate arrangement in the mass. Again, in *Calothrix*, the filaments are fixed at the base, and stand erect in minute tufts, or spread in a velvety pile over the surface of various objects. In *Lyngbya* the arrangement of the threads is similar, but they are of much greater length, more curved and flexible, resembling tufts of hair or silky wool. Lastly, in *Rivularia*, there is a compact gelatinous frond of sub-definite form, constructed of a multitude of symmetrically arranged filaments; each one springing from a minute, spherical, bulb-like cell, by which it is attached to the neighbouring filament. These basal cells have been called "connecting cells," and also "*heterocysts*." Their peculiar function has not been clearly ascertained. Through all the genera of the Order considerable uniformity prevails in the structure of the filaments. The external coating or peripheric portion, called the *sheath*, is a tubular membrane, destitute of markings, hyaline, and apparently formed by the lengthening of a single generating cell. In many cases it is delicately membranous and thin; in others it is thickened; and in some (as in *Petalonema*), the sheath consists of many foliations, one inside the other. In several of the *Rivularieæ* also, the sheath is similarly compound, and frequently plumoso-multifid at the extremity. Within the sheath is the medullary column, or endochromatic part of the filament. This always consists of a series of short, lenticular, densely coloured cells, which in the full grown

filament may be readily separated. They have been described as *sporidia*; but observations on their germination are wanting. Minute *zoospores* have been observed in some. Besides the ordinary sheath which encloses each medullary column, a supplementary sheath is found in some genera, as in *Microcoleus*, enclosing a considerable number of separately sheathed filaments. The origin of this general sheath has not been observed. It probably originates as a simple filament, whose endochrome divides and subdivides longitudinally, thus forming a number of filaments within the body of the older one, whose walls continue to enlarge, being fed by the matter of the contained filaments. This appears, at least sometimes, to be the case: in other cases probably the investing sheath is formed of exuvæ and dead filaments.

Many plants of this Order are celebrated for exhibiting peculiar movements resembling those of animals. Some have a rapid progressive and regressive movement, by which they can change their place, rising or falling in the water; others, while remaining nearly in one place, move from side to side, describing an arc. The genus *Oscillatoria* is so named from the pendulum-like movements of its filaments. Species of this genus are to be found in most pools of stagnant water, and their peculiar movements may be easily observed. These plants occur, when fully developed, in floating, skin-like, slimy pellicles, of a deep green or blackish or blueish colour and gelatinous substance. If a small portion of the floating scum be placed in a cup of water, and allowed to remain for some hours at rest, its edges will become finely fringed with delicate, radiating threads, which extend further and further, from hour to hour; and if the experiment be continued for a day or two, in warm weather, the whole surface of the water will be coated with a thin layer of filaments, which will spread till stopped by the dry edges of the cup. These filaments were at first contained within the gelatinous matrix, and have merely *spread* out, not *grown*, from it, by means of their peculiar movements. These movements are of three kinds:—first, there is the oscillating movement; one end of the thread remaining nearly at rest, while the other sways from side to side, sometimes describing nearly a quarter of a circle in a single *swing*. Secondly, the tip of the filament has a minute movement, bending from side to side, like the head of a worm: and thirdly, there is an onward movement, probably the result of the two former. It is this latter which causes the filaments to radiate and spread out from the edges of the stratum. If a minute portion of a living *Oscillatoria* be placed in water, under a moderately high magnifying power, all these movements can be seen without trouble. They vary in vividness, however, in different species, some being active, and some sluggish; and also according to the state of the weather, being most rapid in warm weather. Some of the species are furnished with minute cilia at the extremities, but these do not seem to take part in the motion.

Oscillatoriaceæ are found in all parts of the world, and under a great variety of circumstances. Not very many, with the exception of the *Lyngbyæ* and *Calothrices*, are marine; the great proportion are found in fresh water. Several occur in hot-springs, even in the Geysers of Iceland; and others inhabit water highly charged with mineral salts or gases. Some are found on damp soil; others under the spray of cascades, and on the gates of canal-locks and about mill-dams. Few pieces of stagnant fresh water are free from them; but rivers and streams are equally furnished, and broad lakes are

sometimes coloured, throughout their whole extent, with minute, perhaps microscopic, species of this Order. The ocean itself, often for many hundreds of square miles, has been found discoloured by microscopic Algæ of this group, belonging to the genus *Trichodesmium*; one of which, of a red colour, is found at seasons abundantly in the Red Sea, and is supposed to have caused that name to be given to the Arabian Gulf. Others are found in the Indian Ocean, one of which is of a bright yellow-green, and sometimes deeply tinges the upper strata of the sea off the coasts of Malacca. Others have been noticed in equal abundance, but less strongly coloured, in various parts of the Pacific, and on the coasts of Australia.

The species are very difficult to determine, and have been too much multiplied by authors: little therefore can usefully be said respecting their geographic distribution. Probably, if they are ever carefully investigated, the same kinds will to a large extent be found in the most distant localities. This at least seems to be the case with some, as *Petalonema alatum*, *Lyngbya majuscula*, *L. ferruginea*, *Calothrix scopulorum*, and many others.

TABLE OF THE NORTH AMERICAN GENERA.

* *Frond filamentous, branched, olive-brown, in fresh water.*

I. PETALONEMA. *Filaments* with a flattened, longitudinally and transversely striate sheath, much broader than the endochrome.

II. SCYTONEMA. *Filaments* with a cylindrical, hyaline sheath, narrower than the endochrome.

** *Frond filamentous. Filaments separate, free, green or purple.*

III. LYNGBYA. *Filaments* very long, flexible, threadlike, bundled together.

IV. CALOTHRIX. *Filaments* short, tufted, erect.

V. OSCILLATORIA. *Filaments* rigid, needle-shaped, lying loosely in a mucous matrix, usually floating.

*** *Frond formed of numerous parallel filaments contained within a simple or branching membranous common-sheath.*

VI. MICROCOLEUS.

**** *Frond formed of numerous radiating filaments invested with firm gelatine; each filament springing from a spherical root-cell.*

VII. RIVULARIA.

I. PETALONEMA, *Berk.*

Filaments stratified, decumbent, free, simple or branched. *Tube* or sheath very wide, flattened, longitudinally and transversely striate, and crenulate at the edge; endochrome olivaceous, annulated, here and there interrupted by a *heterocyst*. *Branches* issuing in pairs, formed by the division and protrusion of the endochrome of the original filament.

A very distinct and easily recognized genus established by Mr. Berkeley in 1833, under the name here adopted; a name changed by Professor Kützinger in 1845 to *Arthrosiphon*, for what reason I am not aware. The Alga on which it is founded was discovered many years previously, in the West of Scotland, by the late Captain Carmichael, and was first figured and described by Dr. Greville as an *Oscillatoria*. It has more recently been found in several parts of Europe, and we have now to record its occurrence in the New Continent. There are few more beautiful objects among the fresh water Algæ, and unlike many of its kindred the fronds perfectly recover their form when moistened after having been dried. When placed under the microscope the filaments present the appearance of a cylindrical central column, containing annulated, olive-coloured endochrome, and a wide winglike border at each side of the column. This border or *sheath* is obliquely striate, the striæ running in an arch from the margin toward the centre, where they become parallel, and are then continued longitudinally downwards along the medullary column, till lost in the density. The margin of the wing is closely crenulate, and in age transversely striate at the crenatures as if jointed. Such is the *apparent* structure: the *real* structure seems to be, that an annulated central filament is enclosed within a number of compressed, trumpet-mouthed gelatinomembranaceous tubular sheaths, one arising within the other, and successively developed as the growth proceeds. These sheaths, thus concentrically arranged, are indicated by the longitudinal arching striæ; and the mouths of the younger sheaths, projecting slightly beyond those of the older, form the crenatures of the margin.

PETALONEMA *alatum*, Berk. *Gl. Br. Alg.* p. 23, t. 7, fig. 2. *Harv. Man. Ed.* 1, p. 168. *Hass. Fr. Wat. Alg.* p. 237. t. 68. f. 6. *Arthrosiphon Grevillii*, Kütz. *Phyc. Germ.* p. 177. *Sp. Alg.* p. 311. *Oscillatoria alata*, Carm. *Grev. Sc. Crypt. Fl.* t. 222. *Harv. in Hook. Br. Fl.* 2. p. 378. (TAB. XLVIII. A.)

HAB. On dripping rocks, under Biddle Stairs, Niagara Falls, abundantly, W. H. H. (1849). (v. v.)

This forms strata of a dark chestnut-brown colour, and of indefinite extent, on the surface of rocks or soil in places exposed to the constant drip of water. The *filaments* are decumbent, lying without order in the gelatinous matrix in which they are developed, and which forms the groundwork of the stratum. They appear to be unattached to the soil, and each filament may be about half an inch in length; but they are commonly found broken off at the inferior end, or the lower portion decays while the upper continues to grow. They are slightly curved, in serpentlike fashion, never quite

straight ; at first they are simple, but now and then they emit lateral branches, which issue at considerable angles, and generally in pairs. When a filament is about to branch, a rupture takes place in the side of the sheath, and the endochrome issues in two portions, one connected with the upper, the other with the lower half of the filament ; these form the nuclei or medullary portion of two new branches, and become duly invested with a membranous sheath, and gradually put on the aspect of the adult filament. The *endochrome* is granular, dark-brown, and annulated at short intervals, the transverse rings being placed very close together in the youngest portions, and less closely in the older, where they are distant from each other about twice the diameter of the column. This annulated endochrome is interrupted at certain fixed places, where an ellipsoidal cell is formed, separating the endochrome of the lower from that of the upper portions. These cells may be compared to nodes, and indicate, if I mistake not, the points where the twin branches issue. I have not, however, noticed their development into branches.

PLATE XLVIII. A. *Fig 1.* Portion of the stratum formed by *PETALONEMA alatum* ; and *fig. 2.* Fronds removed from the same ; the *natural* size. *Fig. 3.* Portion of two filaments *magnified*. *Fig. 4.* Apex of a filament, more highly *magnified*.

II. SCYTONEMA, Ag.

Filaments tufted, mostly basifixed, erect or decumbent, free, flexible, branched. *Tube* or sheath cylindrical, continuous, membranaceous, tough ; endochrome olive-brown, annulated. *Branches* lateral, issuing in pairs, formed by the division and protrusion of the endochrome of the original filament.

When at Niagara Falls in the autumn of 1849, I collected on the rocks under Biddle Stairs specimens of a large decumbent *Scytonema*, which may possibly be referable to one or other of the 50 species named and described by Kützing, but whose characters appear to me to be founded, often, on insufficient data. I am unwilling to add to the synonyms by giving a new name to the American species, and I have not at hand the means of comparing it with more than a few of the recorded species. It is of large size, its filaments being nearly twice the diameter of those of the British *S. myochrous*, which it resembles in its branching. The endochrome is narrower in proportion to the sheath and distinctly annulate ; the annuli rather distant. The sheath is of a deep chestnut brown colour.

Probably several other *forms*, if not species, occur in North America.

III. LYNGBYA, Ag.

Filaments destitute of mucous layer, free, flexible, unbranched, elongated, not oscillating. *Tube* continuous, cylindrical, membranaceous; endochrome green or purple, densely annulated, at length separating into lenticular sporidia. (*Marine or in fresh water.*)

A genus consisting of many species, most of which are found in the sea; several occur in estuaries of rivers and in brackish ditches, and a few are found in fresh water or in thermal springs. From *Oscillatoria* they are known by the absence of a gelatinous matrix and of oscillating movements, and by the greater flexibility of the filaments. From *Calothrix*, to which they are more nearly related, they differ chiefly in habit; especially in the great length of the filaments, and in being rarely fasciculate. The generic name is given in honour of H. C. Lyngbye, a Danish Algologist, and author of an excellent work on the Algæ of Denmark.

1. LYNGBYA *majuscula*, Harv.; filaments thick, very long and tenacious, twisted, issuing in long, crisped bundles from a blackish green stratum. *Harv. Phyc. Brit. t. 62. Kütz. Sp. Alg. p. 283. Lyngbya crispa, Ag. Syst. p. 74 (in part.). Conf. majuscula, Dillw. Supp. t. A. L. maxima, Mont. L. Pacifica, Kütz. Sp. Alg. p. 284. (TAB. XLVII. A.)*

HAB. Long Island Sound, *Professor Bailey*. Peconic Bay, *Mr. Hooper*. Key West, *W. H. H. and Mr. Ashmead.* (v. v.)

Tufts often several inches in diameter, the central portion densely interwoven or stratified, the margins throwing off long bundles or fascicles of free, crisped, or variously twisted filaments, one to two inches in length, and floating freely in the water. The strata at first are attached to the bottom, but with age float to the surface and are cast ashore in large masses. The diameter of the filament is greater than in any other species, being commonly rather more than .05 of an inch. The Key West specimens are rather less broad than usual. The sheath or tube of the filament is thick, and forms a wide, hyaline margin to the dark-coloured, closely but not strongly annulated endochrome.

The *L. maxima*, Mont. (*L. pacifica*, Kütz.) which I have gathered in great abundance on the shores of the Friendly Islands, appears to me to be merely a luxuriant state of this common species. Except in the greater diameter of the filaments, and this varies in different specimens, I see no character by which it may be distinguished. The species (as understood in England) has a peculiar external habit, and its microscopic characters—however difficult to describe—are easily remembered after having once been seen. It was first found at Bantry, South of Ireland, by the late Miss Hutchins.

PLATE XLVII. A. *Fig. 1.* A tuft of *Lyngbya majuscula*, the natural size. *Fig. 2.* Portion of a filament, magnified.

2. *LYNGBYA ferruginea*, Ag. ; filaments slender, flaccid, curved, forming a thin stratum of a verdigris green colour, which gradually changes to a pale chestnut (but resumes the green in drying). *Ag. Syst. p. 73. Harv. Phyc. Brit. tab. 311. L. æruginea*, Kütz. *Sp. Alg. p. 282. (TAB. XLVII. B.)*

HAB. On muddy shores, in tide pools and floating in ditches of salt or brackish water near the sea. Haarlem River, N.Y. close to the High Bridge, *W. H. H.* Salt ditches at Hoboken and near Green Port, *Professor Bailey. (v. v.)*

Stratum thin, expanded, covering the mud to an indefinite extent, or floating on the surface of stagnant salt water, generally of an intense verdigris or blueish green colour, now and then foxy or rust colour, scarcely at all gelatinous. *Filaments* about .001 of an inch in diameter, flaccid, slightly flexuous, rather tough, with very thin, membranous cell-walls, filled with dense closely and strongly annulated, bluish-green endochrome, occasionally with empty spaces. The striæ are very evident. In the dry state the blue-green colour is mostly preserved ; and the surface is not glossy.

PLATE XLVII. B. *Fig. 1.* Portion of the stratum of *LYNGBYA ferruginea. Fig. 2.* Portion of a filament, *magnified. Fig. 3.* Section of the same, more highly *magnified.*

3. *LYNGBYA fulva*, Harv. ; filaments slender, elongate, flexuous, fulvous, issuing in erect, crisped, plumose fascicles from a dark coloured stratum ; cell-wall thick, forming a broad limbus to the endochrome. (TAB. XLVII. F.)

HAB. On the granite masses composing the breakwater at Stonington, Conn. *Professor Bailey. (v. s. in Herb. T.C.D.)*

Stratum attached to the rock, dull olivaceous, throwing up long fascicles of filaments, an inch or more in length, and standing upright in the water. *Filaments* about the size of those of *L. ferruginea*, but with very thick walls, which form a glassy sheath to the enclosed fulvous or ochre coloured endochrome ; the hyaline border being nearly half as wide as the coloured portion. The annuli are strongly marked and very closely set.

This somewhat resembles *L. luteo-fusca*, Ag., but the walls of the tube are much thicker, as thick in proportion to the enclosed matter as are those of *L. majuscula* to the matter in its tube.

PLATE XLVII. F. *Fig. 1.* *LYNGBYA fulva*, the natural size. *Fig. 3.* Portion of a filament, *magnified. Fig. 2.* Section of a filament, more highly *magnified.*

4. *LYNGBYA nigrescens*, Harv. ; filaments very slender, flaccid, densely interwoven into a fleecy, blackish-green stratum. (TAB. XLVII. D.)

HAB. Sea shores or mud, &c. Canarsic Bay, Long Island, *Mr. Hooper. Peconic Bay. W. H. H.* Also on leaves of *Zostera*, Peconic Bay, *Mr. Hooper.*

Strata varying in extent, lying on the surface of mud, or floating, or entangled with other Algæ and attached to them, of a very dull, blackish, or somewhat violet colour, with shades of æruginous green. *Filaments* scarcely more than half the diameter of those of *L. ferruginea*; with thin, membranous cell-walls, and densely annulated, dark or dull coloured endochrome. When dry the stratum becomes brittle, and frequently breaks off from the paper in flakes.

PLATE XLVII. D. *Fig. 1.* *LYNGBYA nigrescens*, the *natural* size. *Fig. 2.* Portion of a filament, *magnified*. *Fig. 3.* Section of the same, more highly *magnified*.

5. *LYNGBYA confervoides*, Ag. ; filaments very slender, flaccid, elongate, forming long, comose fasciculi, floating freely from a blackish green basal stratum ; annuli not very strongly marked. *Ag. Syst. p. 73.* *Kütz. Sp. Alg. p. 285.* (TAB. XLVII. C.)

HAB. Sea-shores, Charleston, S. Carolina, *Professor Lewis R. Gibbes.* (v. s.)

Stratum dark, olivaceous, or blackish green, emitting long bundles of slender filaments, 1-2 inches long, which float freely in the water. Filaments lying parallel in the bundles, flexuous, but scarcely interwoven and often separate ; with very thin, narrow, membranous tubes, and a dense, dull-green endochrome, which is much less distinctly annulated than in *L. ferruginea*. The diameter of the filament is also much less than in that species.

I have compared the above quoted species with an authentic one from Professor J. Agardh, and find little difference between them.

PLATE XLVII. C. *Fig. 1.* *LYNGBYA confervoides*, the *natural* size. *Fig. 2.* Portion of two filaments, *magnified*. *Fig. 3.* Section, more highly *magnified*.

6. *LYNGBYA pusilla*, Harv. ; stratum minute, blackish-green ; filaments very slender, short, crisped, spreading in small bundles ; endochrome pale, dull-green, annulate, cell-wall very thin. (TAB. XLVII. E.)

HAB. Parasitic on small Algæ, at Sullivan's Island, S.C., *W. H. H.* (v. v.)

This spreads over small Algæ in thin strata, composed of densely matted filaments, and emitting to all sides free, fascicled filaments. These latter are about quarter of an inch long, and half the diameter of those of *L. ferruginea*, with a pale endochrome. The cell-wall is extremely thin ; the endochrome quite fills the tube, leaving a scarcely perceptible margin. The annuli are tolerably definite.

Possibly this may be an *Oscillatoria*.

PLATE XLVII. E. *Fig. 1.* *LYNGBYA pusilla*, the *natural* size. *Fig 2.* Portions of three filaments, *magnified*. *Fig. 3.* Section of a filament, highly *magnified*.

7. *LYNGBYA hyalina*, Harv. ; filaments basifixed, erect, straight, very slender, arachnoid, gelatinoso-membranaceous, flaccid, very pale yellowish green or nearly hyaline ; endochrome filling the tube, at first granular, then annulated. (TAB. XLVII. G.)

HAB. On lime encrusted rocks at Key West, *W. H. H.* (v. v.)

Forming indefinite, very soft and sub-gelatinous continuous tufts or pilose strata. *Filaments* fixed by their base to the rock, and floating freely, exceedingly slender and cobwebby, straight, glossy, cylindrical, from half an inch to an inch long, very pale æruginous or yellowish-green, often nearly colourless. The cell-wall is thin and delicate, and the endochrome quite fills the tube, leaving no perceptible margin.

I do not know any species similar to this. It is exceedingly slender and delicate.

PLATE XLVII. G. *Fig. 1.* *LYNGBYA hyalina*, the *natural* size. *Fig. 2.* Portions of three filaments, *magnified*. *Fig. 3.* Section of a filament, highly *magnified*.

8. *LYNGBYA muralis*, Ag. filaments somewhat rigid, thickish, tortuous, very long, interwoven in a bright, grass-green stratum ; annuli strongly defined. *Ag. Syst. p. 74. Harv. Man. Ed. 1, p. 160. Conf. muralis, Dillw. tab. 7, E. Bot. t. 1554. β. aquatica.*

HAB. var. *β*, in pools of fresh water, Whalefish Islands, Davis Straits, *Dr. Lyall.* (v. s.)

The specimens are mixed with turfy soil. Except in the submerged habitat, this agrees with the ordinary form. Intermixed with threads of the usual size and structure are others cohering in pairs, as in *L. copulata*, Hass., which is obviously only a state of this widely dispersed species. I have not received specimens of the ordinary *L. muralis* from America ; but no doubt it is common on damp walls, &c., as in Europe generally.

IV. CALOTHRIX, Ag.

Filaments destitute of a mucous layer, erect, tufted, or aggregated, fixed at the base, somewhat rigid, not oscillating. *Tube* continuous ; endochrome green, densely annulated, at length separating into lenticular sporidia. (*Marine or in fresh water.*)

I retain the genus *Calothrix*, as established by Agardh, in preference to dividing it, with Kützinger and others, into the groups *Leiblinia*, *Tolypothrix*, &c. which appear to me to be separated on very uncertain and variable characters. The whole group requires a careful study and complete remodelling ; but I have neither time nor sufficiently copious materials to attempt such a work. I can hardly suppose that the multitude of species and genera of these obscure plants described by Kützinger are all

distinct. To judge by the characters assigned by him, many appear very closely allied to each other.

1. *CALOTHRIX confervicola*, Ag. ; filaments short, glaucous, opaque, filiform, blunt, rigid, straight or slightly curved, minutely tufted. *Ag. Syst. p. 70. Harv. Phyc. Brit. t. 254. Wyatt, Alg. Danm. No. 229. Leibleinia confervicola, Endl. 3d. Supp. p. 221. Leibleinia chalybea, Kütz. Sp. Alg. p. 277.* (and probably other species of *Leibleinia* of the same author). *Conferva confervicola, Dillw. Conf. t. 8. E. Bot. t. 2576.*

HAB. On the filiform marine Algæ. Rhode Island shores, *Professor Bailey, Mr. Olney, Mr. Hunt.* (v. v.)

Filaments about the tenth of an inch long, either forming little starry tufts along the branches of the Alga it infects, or, by the confluence of several such tufts, covering the branch with a continuous pile of dark æruginous-green threads. When seen under the microscope the filaments are simple, curved, filiform, but little attenuated upwards, and either separate from each other or variously combined by lateral cohesion into fascicles. Their cell-wall is rather thick, and the endochrome within is of a dull bluish-green, here and there interrupted and broken into separate masses, and sometimes nodoso-incrassate at short intervals. The transverse striæ are more or less distinctly seen according to the age of the specimen examined. The colour varies in different specimens, from dull to bright green ; and is sometimes olivaceous, and even yellowish or pale.

This species is a common parasite on the filiform Algæ, and found in many distant seas.

2. *CALOTHRIX scopulorum*, Ag. ; spreading in velvety dull-green strata of indefinite extent ; filaments flexuous, subulate, subattenuate, simple. *Ag. Sp. Alg. p. 70. Harv. Phyc. Brit. t. 58, B. Schizosiphon scopulorum, Kütz. Sp. Alg. p. 329 (and probably others.) Conferva scopulorum, Dillw. Conf. p. 39, Sup. t. A. E. Bot. t. 2171.*

HAB. Rocks near high water mark. Shores of Rhode Island, *Professor Bailey and Mr. Olney.* (v. v.)

This occurs in slimy and somewhat velvety patches of indefinite extent, covering the surface of marine rocks. The filaments rise from a slimy debris or matrix, which is gradually accumulated. They are erect, flexuous, often very much bent, attenuated to the apices, and sometimes, but not invariably, acuminate ; and they stand in the stratum parallel to each other, crowded together, but not cohering in laminæ. The endochrome is commonly of a dark, olivaceous green, and the cell-wall thin and membranous. *Striæ* evident.

Generally dispersed throughout the temperate zones, both north and south. Its slimy patches are very treacherous to the feet of unwary trespassers who may happen to tread on them.

3. *CALOTHRIX vivipara*, Harv. ; spreading in continuous, velvety strata ; filaments thick-walled, fasciculate at base, straight or somewhat curved, viviparous above, and pseudo-branched ; endochrome strongly annulated.

HAB. Seaconnot Point, *Professor Bailey* (v. s. in Herb. T.C.D.)

This appears to form a continuous stratum on rocks, like that of *C. scopulorum*, but the filaments of which it is composed are longer, 2-3 tenths of an inch long and straighter ; more united at the base into fascicles, and furnished above with appositional branches which evidently rise from viviparous separations from the endochrome. Sometimes the endochrome seems to split or divide longitudinally ; at other times it separates transversely, the portions growing at each end and cohering laterally. The cell-wall is wider than in *C. scopulorum*.

Certainly closely allied to *C. scopulorum* and also to *C. hypnoides*, and perhaps intermediate between them, connecting the extreme forms of each. It was sent to me by Professor Bailey as probably *C. fasciculata*, but it does not agree with the British plant so called ; and not knowing what else to do with it, being unwilling to pass it by altogether, I have given it a provisional *locus* in the genus, assigning to it the trivial name *vivipara*. It may possibly be merely a viviparous state of *C. scopulorum*.

4. *CALOTHRIX pilosa*, Harv. ; strata of indefinite extent, blackish or dark brown, pilose ; filaments densely interwoven at the base, then free, elongate, rigid, cylindrical, very obtuse, very flexuous, simple or slightly pseudo-branched ; cell-wall very thick, fulvous or subopaque ; endochrome narrow, dark green. (Tab. XLVIII. C.)

HAB. On rocks between tide marks, Key West, *W.H.H.* (v. v.)

This forms strata of indefinite extent, covering rocks in patches of a very dark blackish or brown colour, not in the least lubricous, and more pilose than velvety. The stratum is about quarter of an inch thick ; its matrix composed of the densely interwoven decumbent bases of the filaments which constitute it. These are afterwards erect, unconnected together, standing separately like the hairs on a fleece, very much curved or twisted, nearly half an inch long, rigid and not at all slimy. They are about the same diameter as *Lyngbya majuscula* ; and are scarcely attenuated at the blunt apex. The cell-wall or tube is remarkably thick and opaque, evidently formed of successive deposits, indicated by faint longitudinal striæ ; and is fulvous or ochraceous in colour. The endochrome seldom constitutes more than a third of the diameter of the filaments, and is of a dull dark-green, more or less annulated. When dry the whole plant is rigid and harsh, and does not adhere to paper.

This seems to be a well characterised species, different at least from any with which I am acquainted, and to be recognised by its shaggy, rigid pile of hair-like filaments, and their dark colour. Its microscopic characters are quite different from those of *C. scopulorum*. It abounds at Key West on littoral rocks.

Plate XLVIII. C. *Fig. 1.* Stratified tufts of *CALOTHRIX pilosa*, the natural size. *Fig. 2.* Portion of the filaments *magnified*. *Fig. 3.* A more highly *magnified* portion.

5. *CALOTHRIX dura*, Harv.; strata indefinite, dull brown; filaments at first decumbent and matted together, then erect, cohering laterally in tooth-like bundles; each filament angularly bent below, at first simple, then cleft longitudinally and afterwards once or twice forked; endochrome very narrow, annulate; the cell-wall thick, lamellated and subopaque; apices acuminate. (TAB. XLVIII. D.)

HAB. On mudflats, near highwater mark. Key West, W. H. H. (v. v.)

Possibly this may be only a state of the preceding species, to which, at least, it is nearly allied, although it offers characters which would cause it to be referred to another genus of Kützinger. The filaments are matted together at base; the mat being composed of prostrate portions of each thread, intricately interwoven. The threads, after proceeding for a time horizontally, suddenly become erect, bending nearly at right angles, and then they cohere together into stiff, tooth-like fascicles, in which they stand parallel, and are straight or but slightly curved. When a single filament is removed from the fascicle, it is seen to be simple and filiform below, but gradually increasing in diameter upwards to a certain stage, at which the endochrome separates into two columns, which are at first parallel with each other and contained in the same sheath; but they soon separate, and then each becomes invested by a separate sheath. In this way two branches are formed, which may either remain simple or may again divide once or twice in a similar manner. The cell-wall is much wider than the endochrome. The substance is rigid and tough: and the colour dull brown or fulvous.

PLATE XLVIII. D. *Fig. 1.* Stratified tufts of *CALOTHRIX dura*, the *natural* size. *Fig. 2.* Portions of the filaments *magnified*. *Fig. 3.* Apex of a filament, more highly *magnified*.

V. OSCILLATORIA. *Vauch.*

Filaments lying in a gelatinous matrix, rigid, simple, acicular, vividly oscillating. *Tube* continuous; endochrome green, densely annulated with close, parallel, transverse striæ. (*Mostly in fresh water—some marine.*)

The *Oscillatoria* occur in gelatinous strata or pellicles, which at first are formed at the bottom of stagnant or running water, and afterwards rise to the surface. The green scum frequently seen on the surface of putrid ditches is generally formed by one or

more species of this genus. Others occur in lakes, and sometimes in such abundance as to impart a blue-green tint to the water, over very wide areas. Others, again, inhabit mineral springs and thermal waters ; and some are found on the damp surface of the soil, especially in the autumnal months. Varied as are the habitats, the general characters of the species are very uniform: and all are remarkable for an oscillating movement of the filaments, from side to side, like the motion of a pendulum. This continues with greater or less vividness, while the plant lives: but some species exhibit much more lively movements than others, and all appear to be more active in warm than in cold weather.

A considerable number of species have been described by authors, but they require to be studied in a living state, or at least with very perfect materials and an ample suite of well preserved specimens. I cannot undertake to name specifically the few scraps of American *Oscillatoria* which have been sent to me by various correspondents. Probably most of the European species will be met with in America ; and no doubt some others peculiar to the New Continent. It would be interesting to know whether any species be found in the Mammoth Cave of Kentucky, or in other anomalous localities.

VI. MICROCOLEUS, *Desmaz.*

(*Chthonoblastus*, Kütz.)

Filaments minute, rigid, straight, annulated, bundled, and enclosed within membranous simple or branching sheaths, which are either open or closed at the upper extremities.

The filaments in this genus have the structure of those of *Oscillatoria* or *Calothrix*, but are developed within membranous common sheaths, which are either simple or branched, and either lie prostrate in indefinite strata, like those of an *Oscillatoria* ; or stand erect, in toothlike tufts, like those of many *Calothrices*. In all cases the sheath is much attenuated at the base, gradually widening upwards, and terminating either in an open, trumpet-shaped upper extremity, or in a closed club-shaped one. In the lowest part of the sheath there is but a single longitudinal filament ; a little way up, two or three parallel filaments are found ; and the filaments gradually increase in number in the upper and wider portions of the common sheath. Hence it may probably be inferred that the mode of growth of the frond is by the continual longitudinal division of the filaments ; the older ones, having once split, remaining unchanged at base ; while their apices by another splitting give birth to other filaments, which multiply in the same manner. Such a mode of growth would account for the form

which the full grown frond assumes. The species are found either in the sea or in fresh or brackish water, and even on damp soil. A terrestrial species is common in Europe by the borders of clayey highways and paths, and may also be found in America.

1. *MICROCOLEUS corymbosus*, Harv.; fronds erect, rigid, tufted, multifid, the branches erect, level-topped, linear-clavate, closed at the extremity; filaments densely packed, not oscillating. (TAB. XLVIII. B.)

HAB. On mud-flats, near high-water mark, at Key West, mixed with *Calothrix dura*. W.H.H. (v. v.)

Fronds half sunk in the mud, erect, tufted, from an eighth to a quarter of an inch in length, flexuous, tapering much to the base, gradually increasing in diameter upwards and dividing above into three or four or more erect branches, the lowest of which are longest, the upper gradually shorter, so that the apices of all are nearly on a level. These apices are obtuse, and closed. The investing sheath is tough and firmly membranous, and the enclosed filaments strongly cohere together, and are with difficulty separated. The colour of the sheath is ochraceous yellow, and of the endochrome dull green. The substance is very firm and rigid, and in drying the plant does not adhere to paper.

PLATE XLVIII. B. *Fig. 1.* Tufts of *MICROCOLEUS corymbosus*, the *natural* size. *Fig. 2.* Magnified view of two fronds. *Fig. 3.* Portions of the enclosed filaments, more highly magnified.

VII. RIVULARIA, Roth.

Frond globose or lobed, fleshy, firm, composed of continuous radiating filaments, annulated within; each springing from a spherical globule. (*In the sea or in fresh water.*)

A fresh water species resembling the British *R. pisum* has been sent to me by Mr. Ravenel from the Santee Canal, where it grows on submerged leaves and stems of plants. It is hemispherical, very convex, dark blackish-green and soft, and consists of densely set, spuriously branching, slender filaments. The specimens are not in a very perfect state, and I cannot say to which, if any, of the modern species they would belong. In old times they would pass for *R. pisum*, but it is nearly impossible at present to say exactly what that species is.

ORDER X.—NOSTOCHINEÆ.

Nostochineæ, Endl. 3rd Suppl. p. 12. Berk. Crypt. Bot. p. 139. *Nostocheæ*, Lindl. Veg. Kingd. p. 18. Kütz. Phyc. Gen. p. 30. *Nostochaceæ*, Harv. Man. Ed. 2, p. 230.

DIAGNOSIS. Green, fresh water, or rarely marine Algæ, composed of moniliform filaments, lying in a gelatinous matrix. *Filaments* formed of globose cells, here and there interrupted by a single cell (*heterocyst*) of a different character. Propagation by *zoospores*.

NATURAL CHARACTER.—The least organized plants of this Order consist of isolated, moniliform threads, invested with a gelatinous coat, and either lying on the soil, without a root attachment, or floating freely in water. Others a little more compound are made up of numerous similar threads aggregated in bundles, and imbedded in a gelatine common to the colony : while even the most complex, as in the genus *Nostoc*, present but little further in advance, except that the gelatine in which the threads are developed is of a firm consistence, when dry becoming quasi-membranous, and assumes the character of a frond, with definite outline, but generally polymorphous shape. The filaments are almost always simple, consisting of strings of cells, and are curved or twisted, or often spiral ; in one case (*Monormia*) the filaments branch. The *cells* are spherical or oval, never truly cylindrical with flat ends, as in the *Confervaceæ*, and are filled with a dense, bright-green endochrome. In some few cases, as in *Spermosira*, the moniliform thread is enclosed within a tubular, membranous sheath, as in *Oscillatoria*, and there is little to distinguish such plants from individuals of that Order, except the occurrence of the cells called "*heterocysts*." These latter cells are destitute of endochrome, but often clothed with cilia, and are of a different size and shape from the neighbouring cells. They are always solitary, and occur at intervals in the filaments, but vary in position in the different species. Their use has not been ascertained, but they have been supposed to be connected with the male system of these plants. They never change character, like the ordinary cells, and are always found occupying a definite position in the filament, indicating that they perform some important function, whatever it may be.

Though the process of fertilization has not yet been observed, there can be little doubt but that a true fructification is formed in the ordinary cells, which at first are filled with pale-green matter, and afterwards increase in size, alter their form, and acquire a much denser and more darkly coloured, often deep brown, endochrome. All the cells of the filaments do not exhibit these changes, but only one or more, generally

those in the neighbourhood of the heterocyst. Finally, at maturity, the threads break up, and the enlarged brown cells are found to contain *spores* which germinate and continue the species. They have been stated to change into zoospores, but this requires confirmation. *M. Thuret*, in a communication recently made to the Natural History Society of Cherbourg (*Aug.* 1857, *vol.* 5) has described and figured the germination of the spores of *Anabaina licheniformis*, and *A. major*. In these species the sporangium is oblong, and contains at maturity a deep brown solitary spore. *M. Thuret* having obtained some specimens with ripe fruit, set them aside in a convenient glass vessel, and observed them from day to day. The filaments soon broke up, the heterocysts and sporangia floating apart in the water. Many of the latter perished, melting away, and disappearing altogether. Some remained sound, and these were carefully supplied with water, until germination commenced. The spore, in germinating, at first lengthens, pushing against one end of the sporangium, which it finally pierces lifting off the tip of the periderm like a lid, and thus its extremity issues, as the radicle from an monocotyledonous seed, capped with the lid of the sporangium. At this period new cells begin to be formed, by the repeated sub-division of the spore, which continues to lengthen till it is transformed into a moniliform filament or string of cells, like that from which it was derived. At first the divisions between the cells are but little distinct, but they become more and more strongly defined as growth proceeds. The filament lengthens at both extremities, but more rapidly at that which projects into the water; the young articulations are of smaller size than the rest, and thus the filament tapers towards each end. But this character gradually disappears, and the cells acquire a uniform dimension, proper to the species. *M. Thuret's* first experiments were made with freshly gathered sporangia: but he afterwards succeeded in causing to germinate specimens which had been dried and preserved for several months in the herbarium. They began to germinate in about a fortnight. Others (of *Anabaina licheniformis*) which had been kept for nine years in a dried state, germinated in an equal space of time, and the experiment was repeated several times with like success. Several other fresh-water Algæ have been observed to possess the same property of revivification, and it seems a necessary endowment to enable them to continue the existence of their species through the alternate drying and moistening to which they are subjected in nature.

To *M. Thuret* we are also indebted for observations on the ordinary propagation by gemmation of the *Nostocs*, and for an account of the way in which the compound frond is developed. In the autumnal months, when this process goes forward, the old *Nostoc* may be said to diliquesce, the gelatine becoming loose and exuding, and the filaments contained in it breaking up into small fragments. If these be collected and placed in a glass of water, they may be observed to have a slow, progressive movement, like that of the *Oscillatoria*, which enables them to change their place; and at length they generally fix themselves on that side of the glass next the light. By continuing the observations for some days, the broken threads are seen to become immoveable, and then to be invested with a transparent pellicle. At the same time the green cells increase in size, expanding laterally, till the thread attains nearly twice its ordinary diameter. A cell division, in vertical order, then takes place throughout its component cells, and thus the filament splits into two parallel filaments, which are then contained

within a common pellicle. The same process continues ; these split into other threads, and thus, by gradual bisection of the first formed threads, the frond grows until it become of the form and size proper to its kind. As it grows the filaments twist and curl, and loose their parallelism. All these changes have been figured by M. Thuret with the accuracy and delicacy of execution characteristic of that accomplished naturalist.

The Nostochineæ are very rarely marine, and are chiefly found in fresh water streams or ponds and lakes, or in damp places. *Nostoc commune* is dispersed over most countries of the globe, being found lying on the bare soil after rains, or in very damp weather. It may be observed often on garden walks in the autumn and winter months, and is found throughout both temperate zones, extending almost to the tropics. A similar species has been seen in Australia, after a shower of rain, to cover what had seemed previously to be a bare hill side, with such a thick coating of jelly as to render it impossible to walk over it without sliding. Such terrestrial species have, in England, the popular name of "fallen stars"; their sudden appearance and disappearance being accounted for by the supposition that they had fallen from the air. In Dr. Sutherland's account of his Arctic voyage a species bearing a close external resemblance to *N. commune* was observed in profusion, occurring on the shores of the Arctic Ocean, but in windy weather frequently blown over the ice, and drifted out to sea. This will be found described below as *N. arcticum*. Dr. Sutherland mentions that he had eaten handfulls of it on several occasions, without any inconvenience ; and although it was generally infested with swarms of the larvæ of flies and gnats, he considered it much more nutritious than "tripe de roche," and perhaps not inferior to Iceland moss. A very similar plant was noticed by Dr. Thomson as occurring in Thibet, up to the height of 17,000 feet, floating on the surface of pools and lakes, in soils impregnated with carbonate of soda, and drifted in heaps by the winds along their banks. Mr. Berkeley, who examined the specimens of both plants chemically, "thinks we may safely assume the jelly of the Nostoc to be a state of bassorin, passing into cellulose or dextrine." Another species of this genus (*Nostoc edule*, Mont. and Berk.) is found abundantly in streams in Tartary, whence it is exported to China, where it is sold in the markets as an article of food, and highly esteemed as an ingredient in soups. It is prepared for sale in boxes, one of which is in the Museum of the Linnæan Society. These particulars are drawn from the abstract of a paper read by Dr. Hooker before the Linnæan Society of London, January 20, 1852. (See Taylor's *An. Nat. Hist.* 2nd. Ser. Vol. 10, p. 301-303.) As the edible Nostocs closely resemble *N. commune* in substance, it may be worth enquiry whether the latter may not also be used as food. Possibly a new source of luxury may lie hid under this humble exterior. Or it may perhaps be a nourishing and delicate food for weak digestions. The dyspeptic had better seek for it betimes.

NOSTOC. *Vauch.*

Fronde gelatinous or coriaceous, globose or lobed, filled with curled, beaded, simple filaments, formed of spherical or ellipsoidal coloured cells, interrupted here and there by a colourless cell of larger size. *Spores* formed from the ordinary cells. (*On damp ground or in fresh water.*)

1. NOSTOC *commune*, Vauch. ; terrestrial ; frond expanded, membranaceous, plaited and waved or curled, olive-green, polymorphous. *Vauch. Tab. 16. Fig. 1, Ag. Syst. p. 18. Harv. Man. Ed. 1, p. 183. Hass. Br. Fr. W. Alg. p. 288 t. 74, f. 2. Kütz. Sp. Alg. p. 298.*

HAB. On damp soil, in autumn. Common after rain on dry flats, Rio Bravo, *Dr. Schott.* (v. v.)

In dry weather the frond curls up and contracts, looking like a piece of shrivelled skin, and in that state may be blown about without injury. When moistened it expands, and then forms a semi-transparent, semi-gelatinous, elastic membrane, of a dull bottle-green colour. Under the microscope it appears like a transparent jelly traversed in every part with curled strings of beadlike, green cells.

2. NOSTOC (*HORMOSIPHON*) *arcticum*, Berk. ; fronds foliaceous, variously plaited, green or brownish ; filaments at length (their gelatinous envelope being dissolved) free. *Berk. in Proc. Lin. Soc. fide An. Nat. Hist. 2d Ser. vol. 10, p. 302.*

HAB. On the naked soil, in boggy ground. Assistance Bay, lat. 75° 40' N. *Dr. Sutherland.* (v. s.)

“*Fronde*s foliaceous, variously plicate, sometimes contracted into a little ball. Gelatinous envelope at length effused ; connecting cells at first solitary, then three together ; threads, which are nearly twice as thick as in *N. commune*, breaking up at the connecting cells, so as to form new threads, each terminated with a single large cell, the central cell becoming free.” *Berk. l. c.*

“It grows,” says Dr. Sutherland, “upon the soft and almost boggy slopes around Assistance Bay ; and when these slopes become frozen at the close of the season, the plant lying upon the surface in irregularly plicated masses becomes loosened, and if it is not at once covered with snow, which is not always the case, the wind carries it about in all directions. Sometimes it is blown out to sea, where one can pick it up on the surface of the ice, over a depth of probably one hundred fathoms. It has been found at a distance of two miles from the land, where the wind had carried it. At this distance from the land it was infested with Poduræ, and I accounted for this fact by presuming that the insects of the previous year had deposited their ova in the plant upon the land, where also the same species could be seen in myriads upon the little purling rivulets, at the side of which the Nostoc was very abundant.” At p. 205 of his Journal, Dr.

Sutherland further mentions having tried it as an article of food, and found it preferable to the Tripe de Roche of the arctic hunters. Its nutritive qualities are probably equal to those of the jelly derived from other Algæ.

3. *NOSTOC verrucosum*, Vauch. ; aquatic ; fronds large, gregarious, confluent, subglobose, plaited, at length hollow, blackish-green. *Vauch. t.* 16, *fig.* 3. *Ag. Syst. p.* 21. *Harv. Man. Ed.* 1, *p.* 185. *Hass. Brit. Fr. Wat. Alg. p.* 291, *tab.* 75, *fig.* 1. *Kütz. Sp. Alg. p.* 300.

HAB. On stones in fresh water streams. Pools of fresh water, Isle of Disko, and at Beechey Island, Arctic Regions, *Dr. Lyall*. Santa Fe, New Mexico, *Fendler*.

Fronds gregarious, at length confluent, adhering firmly to the rock on which they grow, becoming hollow and torn in age, and finally floating to the surface. *Colour* a bottle-green. Glossy when dry.

4. *NOSTOC cristatum*, Bailey ; aquatic, fronds orbicular, plano-compressed, firm, smooth or tuberculated, attached by a point of the circumference, erect. *N. nummular*, *Harv. MS. in Herb.*

HAB. In rivulets, attached to stones under water. Near West Point, *Professor Bailey*. Crumelbow Creek, Hyde Park, N.Y., *W.H.H.* (v. v.)

This pretty little species grows on stones in running water and may possibly be of common occurrence. The fronds are circular, about half an inch in diameter, or rather more, the tenth of an inch in thickness, plano-compressed and solid ; but perhaps in age they would become hollow, and then would probably be spherical. Such inflated fronds, however, have not yet been seen. They are fixed to the stones on which they grow by a single point of the circumference, and stand erect, like miniature cock's-combs, whence the specific name *cristatum* bestowed by *Professor Bailey*. The substance is very firm and cartilaginous. The filaments are much curled and very densely packed together, moniliform, and of a dark bluish-green under the microscope. The colour of the frond to the naked eye is a dark olive-green, blackish rather than blueish.

5. *NOSTOC Sutherlandi*, Dickie ; "discoid, coriaceous ; filaments crowded ; cells mostly spherical." *Dickie in App. Suth. Voy.* 1, *p.* 193.

HAB. South side of harbour, in winter quarters, Baffin's Bay, July, 1851. *Dr. Sutherland*.

"The plant is one to two inches in diameter, attached by one point of the margin. Plicato-venose beneath, the plicæ radiating chiefly from the point of attachment ; faintly venose above, especially near the point of adhesion ; toward the margin reticulately venose." *Dickie, l. c.*

This is unknown to me. It seems to be closely allied to the preceding species, if it be distinct. The plicæ and reticulations observed do not appear to be characters of much value for the discrimination of species among these gelatinous plants.

6. *NOSTOC microscopicum*, Carm. ; fronds densely aggregated, very minute, globose or oblong, immersed in a blackish crust ; filaments few. *Carm. in Hook. Brit. Fl.* 2, p. 399. *Harv. Man. Ed.* 1, p. 184. *N. muscorum*, Hass. *Br. Fr. Wat. Alg.* p. 292, t. 74, fig. 4.

HAB. "Stones in a small stream, Baffin's Bay, *Dr. Sutherland*, fide *Prof. Dickie*.

I have not seen American specimens. In Britain this species grows among mosses on exposed calcareous rocks, but not in water. The above specific character is taken from the British plant. The fronds are rarely more than the tenth of an inch in diameter, and contain two or three beaded filaments lying in a copious transparent jelly.

7. *NOSTOC flagelliforme*, Berk. and Curt. ; terrestrial ; frond cartilaginous, linear, very narrow, compressed and often channelled, much branched, irregularly dichotomous ; branches solid, densely filled with moniliform curved threads. *Berk. and Curt.* No. 3809.

HAB. On naked aluminous soil, at San Pedro, Texas, *Mr. Charles Wright* (v. s.)

Fronds several inches in length, half a line in diameter, lying prostrate on the surface of the soil, much branched in an irregularly dichotomous manner : branches exactly linear, compressed, often channelled on one or both sides, thinned in the middle and incrassated to the edge. *Substance* firm and elastic, cartilaginous, solid, densely filled with moniliform, curved or curled, interlaced threads, which are set longitudinally in the frond, and lie nearly parallel to each other. *Colour* dark olive.

A very curious and most distinctly marked species, differing from others of this genus, much in the same manner that *Chætophora endiviæfolia* does from the ordinary globose forms of *Chætophora*.

ORDER XIII.*—PALMELLACEÆ.

Palmellaceæ, Harv. *Man. Ed. 2*, p. 234. *Palmelleæ*, Dne. *Class*, p. 31. *Endl. 3rd. Supp.* p. 10. *Kütz. Phyc. Gen.* p. 166. *Hass. Brit. Fr. Wat. Alg.* p. 306. *Lindl. Veg. King.* p. 18. *Kütz. Sp. Alg.* p. 196. *Berk. Crypt. Bot.* p. 114. *Thwaites, in An. Nat. Hist. 2nd Ser. vol. 2*, p. 312, and *vol. 3*, p. 243. *Part of Ulvaceæ*, Harv. *Man. Ed. 1*, p. 169. *Part of Nostochineæ*, Ag. *Syst.* p. 13. *Harv. in Hook. Br. fl. 2*, p. 394.

DIAGNOSIS. Green or red, orange or yellowish, fresh-water Algæ, composed of separate or aggregated (but not united) globose or ellipsoidal cells, free, or lying in a gelatinous matrix ; sometimes stipitate. *Propagation* by division of the endochrome.

NATURAL CHARACTER. The plants of this family are the simplest in organization of any of the great class of the Algæ, and therefore fall to the lowest point of the scale in the arrangement we have adopted. In them we no longer find any distinction of root from frond ; most of them are amorphous masses of gelatinous substance, and only in a few, as in *Hydrurus*, does the gelatine assume a tolerably definite form, and display itself as a branching frond. The simplest of the group (*Protococcus*) consists of single, isolated cells, strewn on the surface of the soil or of whatever object to which they happen to attach themselves. These cells are globose or egg-shaped, have a hyaline, often gelatinous coat, and contain a utricle filled with dense endochrome of various colours ; sometimes green, but often red or orange. Of this character is the Red Snow plant (*Protococcus nivalis*) which has attracted so much notice, from the accounts of arctic travellers, and which may often be seen tinging the snows of Mount Blanc and other snowy Alps with a pale roseate hue. The mode of propagation of this primordial plant is as simple as its structure. The matter in the cell becomes condensed at maturity, and then subdivides into 4, 8, 16, or more parts, on a quaternary scale of increase ; each frustule acquires a new cell-coat while yet within the parent cell, and when the process is completed, and all the endochrome of the mother cell has thus been used up in providing for the progeny, the cell-coat bursts and a multitude of minute cell-plants, similar in all respects to the parent except in size, are launched into the world. These grow till they attain the dimensions of the parent, when a similar cell division takes place ; and thus in a very few generations millions of new plants may be produced from a few or even from a solitary original. As the process of growth and

* Orders XI. *Desmidiaceæ*, and XII. *Diatomaceæ* are omitted in this work ; the American species having been already partially described and published by Professor Bailey, and the author not being supplied with any new materials for publication.

development is very rapid, we may easily account for the rapidity with which the *Protococcus nivalis* has been seen to extend, and also for the vast surface covered by so minute an organism. Each individual is not more than $\frac{1}{1000}$ of an inch in diameter, yet the surface of snow visibly reddened by the congregated masses often covers hundreds of square miles. A species very similar, if really different, called *P. pluvialis*, is found in shallow pools of rain water, on the surface of rocks, in gutters of houses, &c.; and has been noticed in very distant parts of the globe under various climatal conditions; and of this species a most elaborate monograph,* illustrated by figures, has been given by De Flotow, in the *Nov. Act. Leop. Carol. Nat. Cur. vol. 20*, where no less than twenty-two distinct and many more subdistinct varieties, or rather states, are enumerated, described, and measured to fourteen places of decimals (!) and figured. Several of these forms are endowed with movements resembling those of the infusorial animalcules, and have been described as animalcules by Shuttleworth in his account of the Red Snow (*Bib. Univ. Geneva, Feb. 1840.*)

A little higher in organisation than *Protococcus* is the genus *Gloeocapsa* (*Hæmatococcus*) in which what is only a passing phase of the *Protococcus* becomes a permanent character. In this we have several cells (of the structure of *Protococcus*) enclosed within a common, primary cell, which is persistent, or at least partially so. In some species (as in *G. Hookeri*) the primary cell-coat exfoliates repeatedly, the old coats remaining permanently attached on one side to each other, and to the cell, which perpetually bursts through them; and thus a sort of spurious frond, simple or branching, is formed, consisting of exuviæ, each branch being tipped with the living cell, which shines like a gem at its summit. These plants occur generally in damp situations, on rocks and among mosses, about the spray of cascades, &c., and Kützing has described and figured upwards of fifty.

Next come the *Palmellæ* proper, where a large number of protococcoid cells are enclosed within a common gelatine, in which they sometimes appear to be distributed without order; and sometimes arranged in a subquaternary manner. In this latter case the structure approaches very closely to that of *Tetraspora*, a genus we have already referred to the *Ulvaceæ*; but which is placed by many authors next to *Palmella*. Possibly among these obscure plants forms are associated in one genus which will be separated when their development is better understood. Among some of the *Palmellæ* Broome and Thwaites have described and figured a more definite organization than was previously known; namely, that the apparently scattered cells of the mass are connected in an early stage of growth, by means of slender gelatinous threads, with a central cell

* This extraordinary essay is well worth looking at—(I will not say carefully perusing)—as one of the most remarkable commentaries on the text, “how great a flame a little fire kindleth.” The object to be examined is a microscopic Alga of the simplest possible structure, being in fact merely an isolated living cell. All that need to be said of its history might, one would suppose, easily have been written in a page or two. But the learned and most laborious author has occupied nearly two hundred large quarto pages on this theme; and not content therewith, has appended long tables of decimal measurements of microscopic areas and volumes, whose only reference to his subject appears to be that they enable him to arrive at such important calculations and useful results as describing the mean differences of the shorter and longer diameters of different individuals of his *Protococcus*, and their mean comparative bulk and spherical aberration. In computing these tables, the decimals have been carried sometimes to fourteen places, and in most cases at least to six.

of large size, from which they radiate. Afterwards they become detached, and then each is seen at the end of a mucous prolongation similar in appearance to that already noticed as occurring in *Gloeocapsa*. Mr. Thwaites compares these threads to the mycelium of a fungus, but regards the increase of cells by cell-division as properly an act of gemmation and not of true reproduction. The reproductive process in these plants is by conjugation of two cells, which takes place in a manner similar to that already noticed as occurring in *Zygnemaceæ*. A narrow connecting tube, soon enlarging to the breadth of each cell, is formed between two contiguous cells, through which the contents of both cells are mixed together; and thus a *sporangium* filled with a denser and more distinctly granular endochrome is formed, the membranes of the original cells being absorbed in the process. Probably at a future stage the contents of this sporangium are resolved into zoospores. (See *Thw. An. Nat. His. ser. 2, vols. 2 and 3.*)

Higher in structure than *Palmella*, and showing some approaches to the *Nostochineæ*, or even to the gelatinous CONFERVACEÆ (*Chaetophora*) is *Hydrurus*, the only genus which we shall further describe.

I. HYDRURUS, Ag.

Frond fixed at base, cylindrical or compressed, elongated, branched, gelatinous. *Structure*: seriated, but separate, cellules, filled with bright-green endochrome, enclosed in gelatinous parallel tubes, ranged longitudinally in the frond, and surrounded by a common gelatinous envelope.

Of this genus several species have been described by authors, all having a close resemblance to each other, and all very variable in ramification. Indeed it is almost impossible to fix characters by which they can be permanently kept apart; and instead of adding another specific name to the already too numerous list, I prefer to consider the American specimens received as constituting a luxuriant variety of the best known of the established species. All previously recorded species or varieties of these plants are natives of rapid rivers and streams in various parts of Europe.

1. *HYDRURUS penicillatus*, var. *occidentalis*, Harv.; frond very long (1–2 feet or more) much branched; branches very irregular, scattered or crowded, wormlike, tapering to a fine point, naked or clothed with feathery villous ramuli; cells ellipsoidal or pearshaped, twice as long as their diameter.

HAB. On the rocky bottom of rivers and streams, in a strong current. Santa Fe, New Mexico, Mr. Fendler, February to April, 1847. (v. s. in Herb. T.C.D.)

*Fronde*s attached at base, one or two feet long, from one to four lines in diameter, very much and irregularly branched ; branches scattered or crowded, simple or divided, a foot or more in length, attenuated to a fine point, sometimes smooth and naked, but generally densely clothed with slender, villous ramenta, spreading to all sides. The gelatinous tubes or sheaths in which the cells are seriated are very obvious, and lie close together in longitudinal, parallel strata. The cells are of large size, bright-green colour, and variable shape ; some are twice as long as others.

This I had at first supposed to be a new species, but now regard it as a very gigantic state of *H. penicillatus*, Ag. which under various forms and of various sizes is common in alpine streams in Europe. I fear characters derived from the shape and size of the cellules are not more to be depended upon than are those taken from the ramification.

SUPPLEMENT.

No. 1. Additional Species discovered since the publication of the
First and Second Parts.

PART I.—MELANOSPERMEÆ.

Part 1, p. 61, add,

I.* TURBINARIA. *Lamour.*

Root branching. *Fronde* alternately decompound, having a distinct stem, branches, vesicated leaves and receptacles. *Branches* filiform, simple or pinnate. *Leaves* spirally inserted, on long petioles, peltate, becoming inflated and changed into peltate air-vessels with leafy dentate margins. *Receptacles* cylindrical, verrucose, much branched, rising from the petiole of the leaf, near its base, on the upper side ; of similar structure to those of *Sargassum*.

A genus consisting of two or three tropical or subtropical Algæ, distinguished from *Sargassum* by its peltate leaves, which are at first thin and flat, but afterwards become hollow and are changed into flat-topped, margined air vessels.

1. *TURBINARIA vulgaris*, Ag. ; frond membranaceo-coriaceous ; leaves on an inflated petiole obconic or top-shaped, the margin entire or toothed, the disc naked. *J. Ag. Sp. Alg.* 1, p. 267. *Turbinaria denudata* and *T. decurrens*, Bory. *Fucus turbinatus*, *Turn. Hist. t.* 24, fig. a. and b.

HAB. At Key West, *Mr. Ashmead.* (v. v.)

Root a mass of branching fibres, as thick as sparrow's quills, loosely entangled together. *Fronde* several from the same mat of roots, either quite simple, or dividing near the base into three or four principal branches ; or pinnately compound by the evolution of lateral branches, erect and rigid, 6–10 inches high, cylindrical and smooth. *Leaves* spirally inserted, spreading to all sides, patent, rigid ; petioles at first cylindrical,

then becoming clubshaped and somewhat inflated, from half an inch to an inch long, crowned with a peltate horizontal lamina, which is either subentire or sharply dentate at the margin. In young specimens or on young branches the peltate leaves are found flat and thin, their upper and lower surfaces forming one substance; but more commonly the centre of the leaf becomes inflated or vesicated, and then is formed a compound top-shaped flat-topped body, half vesicle, half leaf, which is characteristic of the genus. *Receptacles* dichotomous, much branched, shrubby, their branches verrucose. *Colour*, when growing a pale olive, but in the herbarium changing to a dark brown or black. *Substance*, when dry very hard and rigid.

A common plant in tropical seas, both in the eastern and western hemispheres. Mr. Ashmead obtained fine specimens at Key West, but it appears to be of rare occurrence.

Part 1, page 64, add,

III.* CYSTOPHYLLUM.

(Generic character the same as that of *Cystoseira*, except that the *air-vessels* are confined to the ultimate ramuli, which are simple and filiform.)

1. CYSTOPHYLLUM *geminatum*, Ag. ; stem ; fronds elongate, filiform, unarmed, decompound-pinnate ; branches issuing from all sides, geminate ; vesicles solitary in the ramuli near the summit, oval, tipped with an excurrent point ; receptacles paniculate, warted, attenuate, often tipped with a vesicle. *J. Ag. Sp. Alg.* 1, p. 232. *Cystoseira thyrsigera*, Post. and Rupr. *Ill. Alg.* 13, t. 38, f. 4.

HAB. Banks' Island, North Western America, *Mr. Menzies*, 1787. (v. s.)

In Mr. Menzies' Herbarium, now preserved at the Botanic Garden, Edinburgh, is a specimen of this plant, marked *C. trinodis* in Mr. Menzies' handwriting. Two branches are laid on one piece of paper. The largest is about 10 inches long, as thick as sparrow's quill, smooth, decompound, pinnate and ovato-lanceolate in circumscription. The branchlets are mostly geminate, filiform, alternately decompound ; their lesser divisions also subgeminat. *Vesicles* oval, $1\frac{1}{2}$ lines long, scarcely a line wide, either solitary in the filiform ramuli, about the middle or a little beyond it, or two in the ramulus, the second one terminal, apiculate, and removed by a rather long pedicel from the first. *Receptacles* lanceolate, 2-3 lines long, verrucose, apiculate, often with a slender beak nearly as long as the receptacle, and sometimes two receptacles occur on the same ramulus. The upper branches are very dense.

Page 71, add,

8. FUCUS *serratus*, Linn. ; frond flat, dichotomous, midribbed, serrated, without air-vessels ; receptacles flat, terminating the branches, serrated. *J. Ag. Sp. Alg.* 1, p. 211. *Kütz. Sp. Alg.* p. 590. *Turn. Hist.* t. 90. *E. Bot.* t. 1221. *Harv. Phyc. Brit.* t. 47, &c.

HAB. On rocky sea-shores. Newbury port, Mass. *Captain Pike*, 1852. (v. v.)

Fronds, two feet long or more, from one half-inch to one or two inches in width, dichotomous, with a thick midrib, bordered by a sharply serrated lamina. *Air-vessels* none. *Receptacles* flat, formed in the acuminate extremities of the branches, sharply serrate like the other parts of the frond.

I have received a small fragment of this common European plant, stated to have been found in the above locality on the American coast. It is hardly probable that it is either confined to one locality, or even rare, wherever it occurs; yet none of my other American correspondents have sent it; nor do I know the circumstances under which Captain Pike obtained it. I hope this notice may lead some one on the coast to investigate the subject; for European botanists are yet uncertain whether *F. serratus* be really a bona fide native of the American coast, or merely a stray waif, accidentally cast ashore.

Page 106, add,

2. *ZONARIA flava*, Ag.; frond erect, with an elongated, branched, woolly stipes, the branches expanding into cuneate, flabelliform, vertically cleft and laterally lacinated, naked laminæ; segments wedge-shaped, with radiating, longitudinal striæ; sori roundish, scattered. *J. Ag. Sp. Alg.* 1, p. 110. *Stypopodium flavum*, Kütz. *Sp. Alg.* p. 563.

HAB. Pacific Coast, *Dr. Schott*. (v. s.)

A small specimen, apparently referable to this species, was collected by Dr. Schott on the Pacific coast, but the locality is not stated. It is about two inches high, much narrower and more branched than *Z. lobata*, with stupose, linear, riblike patches extending up the principal lobes. Perhaps, therefore, it is rather referable to *Z. stuposa*, J. Ag., if that be a distinct species from *Z. flava*.

Page 113, add,

VI.* *STRIARIA*, Grev.

Root a small, naked disc. *Frond* tubular, membranaceous, continuous, branched. *Fructification*, groups of naked, roundish spores, disposed in transverse lines.

1. *STRIARIA attenuata*, Grev.; branches and ramuli mostly opposite, tapering to each extremity. *Grev. Crypt. Fl. Syn.* p. 44. *tab.* 288. *Alg. Brit.* p. 55. *t.* 9. *Wyatt, Alg. Danm.* No. 160. *J. Ag. Sp. Alg.* 1. p. 80. *Harv. Phyc. Brit.* t. 25. *Kütz. Sp. Alg.* p. 553. *Phyc. Gen.* t. 21. *f.* 11.

HAB. Flushing, New York Bay, *Professor Bailey*.

The only American specimen I have yet seen is small and very slender, about two and a half inches long, and not thicker than hog's bristle. It is abundantly in fruit; otherwise it could hardly be recognised. The branches are few, opposite or alternate, some of the larger ones bearing a few ramuli, and all tapering to a very fine point.

On the British coast this species varies greatly in size. Sometimes it is nearly as small and slender as that just noticed. Other specimens, like that figured in Phyc. Brit. are 8–12 inches long, and from one to two lines in diameter. The branching is irregular and sometimes whorled.

Page 137, add,

3. *SPHACELARIA arctica*; filaments naked at the base, erect, elongate, slender, irregularly branched, scarcely pinnate; ramuli filiform, naked, erect.

HAB. In tide pools, Isle of Disko, Greenland, *Dr. Lyall*. (v. s. in Herb. T.C.D.)

Filaments 1–2 inches high, irregularly once or twice compounded, the main branches few, the secondary numerous, densely set and very erect, lateral, either naked or bearing few or many, long, filiform, erect, naked, slender ramuli, from half an inch to an inch in length. *Articulations* short in the stem and branches; once and a half as long as broad in the ramuli. *Colour* a dull olive. *Fruit* unknown.

Page 138, add,

III.* MYRIOTRICHIA, *Harv.*

Frond capillary, flaccid, jointed, (simple), beset with quadrifarious, simple, spinelike ramuli, clothed with byssoid fibres. *Fructification*, elliptical spores, containing dark-coloured endochrome.

1. *MYRIOTRICHIA filiformis*, Griff.; stem filiform, slender, often flexuous or curled, beset at irregular intervals with oblong clusters of short, papilliform ramuli. *Harv. Phyc. Brit. t. 156. Wyatt, Alg. Danm. No. 213. J. Ag. Sp. Alg. 1. p. 14. Kütz. Sp. Alg. p. 470.*

HAB. Parasitic on *Dictyosiphon foeniculaceus* at Penobscot Bay, *Mr. Hooper*. (v. v.)

Fronds an inch or more in length, very slender, filiform, but thickened at intervals, as if nodose; the thickening caused by the dense aggregation of short ramuli of two or three cells each. These ramuli emit byssoid fibres. *Spores* roundish, scattered. *Substance* soft. It adheres closely to paper.

On the British Coast this parasite commonly infests *Chorda Lomentaria*.

Page 139, add,

2* *ECTOARPUS longifructus*, Harv.; tufts large, branching, the divisions feathery; filaments robust, excessively branched, branches mostly opposite, the lesser ones set

with short, spine-like, opposite, or rarely alternate ramuli ; articulations as long as broad ; silicules very long, linear-lanceolate, attenuate, densely striate transversely, terminating the principal branches and ramuli. *Harv. Phyc. Brit. t. 258.*

HAB. Penobscot Bay, *Mr. Hooper.* (v. s.)

I have seen an American specimen collected by Mr. Hooper, which I venture to associate with the Orkney plant to which the above character is given in *Phyc. Brit.* Perhaps it is a mere form of *E. littoralis*; though a remarkable one.

Page 140, add,

3* *ECTOCARPUS amphibius*, Harv.; tufts short, loose, soft, pale olive ; filaments very slender, sub-dichotomous ; ultimate branches alternate, spreading ; articulations two or three times longer than broad ; silicules linear-attenuate, spine-like, mostly sessile, scattered. *Harv. Phyc. Brit. t. 183.*

HAB. In fresh (probably brackish ?) water, near New York, *Mr. Hooper.* (v. s.)

Tufts 2-3 inches long, very flaccid and slender ; pale brown when fresh, fading to a dull greenish-olive in drying. This is nearly related to *E. siliculosus*, and may perhaps be regarded as a depauperated variety of that common species, altered by having grown in a less saline medium than usual. In England it occurs in brackish ditches near the coast. The American locality is not particularly specified.

PART II.—RHODOSPERMEÆ.

Page 23, add,

7. *CHONDRIA nidifica* ; frond ultrasetaceous, filiform, sparingly and distantly branched ; branches alternate or secund, quite simple or forked, long, cordlike, naked, or emitting at intervals fascicles of forked or multifid fructiferous ramuli ; tetraspores several, near the tips of the ramuli. (TAB. L. B.)

HAB. Pacific Coast, *Dr. Schott.* (v. s. in Herb. T. C. D.)

Fronds 6-8 inches long, as thick as sparrow's quills, cylindrical, inarticulate, sparingly branched in a manner between alternate and dichotomous ; the branches, by frequent non-development of one of the arms of the fork, appearing unilateral. *Branches* several inches long, quite simple, or once or twice forked ; or bearing a few secondary branches one or more inches long, either quite naked or furnished at intervals of about an inch with tufts of short, fructiferous ramuli. These latter are about quarter-inch long, as thick as hog's bristle, densely tufted, and simple or sub-divided. In the specimen examined some of them bear tetraspores. A transverse slice of the inarticulate frond

shows a central axial-cell surrounded by several primary radiating cells, and many external rows of secondary cells which become smaller towards the circumference. *Colour* a dull brownish red. *Substance* cartilaginous, not adhering to paper.

I have seen but a single specimen of this seemingly very distinct plant, which has more the habit of *Champia lumbricalis* than of one of the present genus. It was picked up, it is presumed on the Western coast, by Dr. Schott, during the Mexican Boundary Survey, but no note regarding its exact habitat accompanied the specimen. I am indebted to my friend Professor Torrey for specimens of this and other Algæ collected by the officers attached to the Mexican Boundary Survey.

PLATE L. B.—*Fig. 1.* CHONDRIA *nidifica*; the natural size. *Fig. 2.* Portion of a branch, with a tuft of ramuli. *Fig. 3,* a ramulus, containing tetraspores. *Fig. 4,* a tetraspore. *Fig. 5,* transverse section of a branch; the latter figures more or less *magnified*.

Page 26, add,

4.* RHODOMELA *lycopodioides*, Ag.; frond divided near the base into several long, simple branches, which are densely beset with slender, finely divided branchlets, mixed with the short, rigid, bristlelike remains of a former series. *Ag. Sp. Alg. 1. p. 377. Harv. Phyc. Brit. t. 50. Lophura lycopodioides, Kütz. Sp. Alg. p. 850. Fucus lycopodioides, Linn. Turn. Hist. t. 12. E. Bot. t. 1163.*

HAB. Whalefish Islands, Davis Straits, *Dr. Lyall.* (v. s.)

*Fronde*s 1–2 feet long, half a line in diameter at base, attenuated upwards, filiform, either quite simple or divided a short way above the root into several long simple branches. In its winter state the virgate branches are closely set with short, rigid, simple or slight divided ramuli, from half an inch to one inch in length. In summer, long, capillary, multifid ramuli from one to two inches in length are thrown out both from the remains of the winter ramuli and from the main branches, and the frond thus acquires a plumose aspect very different from its winter state. *Conceptacles* are abundantly borne on the summer ramuli; and *tetraspores*, lodged in clustered, podlike branchlets or stichidia, are found on the winter ramuli. *Substance* cartilaginous. *Colour* a purplish brown, becoming very dark in drying.

This interesting addition to the American Nereis occurs abundantly in various places on the shores of Northern Europe. In the British Isles it is almost confined to the coasts of Scotland and of the North of Ireland; but has occasionally been met with on the East coast of England.

Page 59,

1. DASYA GIBBESII, Harv.

Add to the description: *Conceptacles* of large size ($\frac{1}{16}$ inch in diameter), borne on the penultimate ramuli, at first globose, afterwards broadly ovate, inflated, with thin, highly cellular walls and a berry-like nucleus of much branched filaments, bearing many

small, pyriform spores. Specimens in fruit communicated by *Mr. S. Ashmead* from Key West. (v. s.)

Page 61,

3. *DASYA ramosissima*, Harv.

Add to description : *Conceptacles* sessile on the lesser branches, ovato-globose, thin walled, inflated, without prominent orifice, containing a large nucleus. *Stichidia* on the ramelli, either fusiform or ovato-acuminate, always tapering to a slender point ; tetraspores in a single or double row. Specimens in both kinds of fruit communicated by *Mr. S. Ashmead* from Key West. (v. s.)

Page 62, add,

3.* *DASYA Harveyi*, Ashmead ; rose red ; stem cartilagineo-membranaceous, longitudinally striate, glabrous, inarticulate, robust, attenuated upwards, much branched ; branches alternate or secund, once or twice decompound, their ultimate divisions being pinnated with capillary, closely set, articulated (polysiphonous) ramuli, which are densely clothed with byssoid, dichotomous ramelli ; cells of the epidermis of the branches very narrow, parallel ; articulations of the ramelli many times longer than broad ; conceptacles sessile near the tips of the lesser ramuli, urceolate, with a prominent orifice ; stichidia on the ramelli, tapering to each end. (TAB. L. A.)

HAB. Key West, *Mr. Ashmead*. (v. s. in Herb. T.C.D.)

Frond 8—10 inches long, as thick as crow-quill in the main divisions ; very much branched, the successive divisions being more and more slender, till the ultimate ones have become finer than human hair. The branching is irregular, the larger divisions frequently secund, several lateral branches directed successively first to one side and then to the opposite one of the main branch. All the main *branches* and their lesser divisions down to the last are inarticulate, being coated with very slender, coloured, longitudinal, parallel, seriated cells, which give the branches a striated appearance under the microscope ; they are also glabrous, or bare of ramelli. The *ultimate* branchlets, which are half an inch to an inch long, are plumose, very flaccid and soft, and closely set with lateral, but not strictly distichous pinnules, which are clothed with excessively slender, cobweb-like, flaccid ramelli. These latter are many times dichotomous and taper to the points ; their articulations are many times longer than broad. The *conceptacles* are nearly of the form of those of *Polysiphonia urceolata*, and are sessile at or near the ends of the pinnules of the plumose branchlets. The *stichidia* spring from the lower forkings of the byssoid ramelli, and are much attenuated, tapering at each end, and containing a double row of tetraspores. The whole plant is of a beautiful, clear, rose-red colour. Its substance is very soft and flaccid, and in drying it adheres very strongly to paper.

For fine specimens of this distinct and beautiful species I am indebted to its discoverer Mr. Ashmead of Philadelphia, who sent them to me marked with the specific name here adopted.

PLATE L. A. *Fig. 1.* *DASYA Harveyi*, the *natural* size. *Fig. 2.* A ramulus bearing a *conceptacle* near its summit. *Fig. 3.* Portions of different ramelli bearing *stichidia*. *Fig. 4.* A portion of a branch, showing the linear striæform surface-cells: the latter figures *magnified*.

Page 64,

7. *DASYA Tumanowiczi*, Gatty. add to the description: *Conceptacles* on very short peduncles, borne by the lesser branches, ovate or sub-urceolate, thin walled, without prominent orifice, with a large nucleus. Specimens from *Dr. Blodgett* and *Mr. Ashmead*.

Page 105, add,

3. *NITOPHYLLUM Fryeanum*; frond sessile, full-red, nerveless, thickish, deeply divided into many cuneate lobes, which are again vertically cleft, the segments rounded, frequently crisped at the margin, specially towards the base, the sinuses narrow; fruit.....?

HAB. Golden-gate, California, *Mr. A. D. Frye*. (v. s. in Herb. T.C.D.)

I propose this species with much hesitation, having as yet seen only very imperfect specimens, which I know not how to dispose of but by giving them a local habitation and name. Two specimens are before me; one faded, the other in a better state of preservation, but neither in fruit. The frond is about 3 inches long, and 4 in lateral expansion, and is deeply divided into 4 or 5 principal segments which are broadly cuneate, and each again partially cloven into 4 or 5 lesser, vertical segments. The margin towards the base of the lobes is crisped or undulate; in other parts it is plane. The lesser lobes are somewhat crenate or sub-lobulate, and all the tips are rounded, and the axils or sinuses very narrow. The substance of the membrane is thickish; the surface-cells large and tessellated; the cells of the interior appear also to be of large size, and quadrate, but the specimens examined have been too much squeezed in the process of drying, and their cells are consequently broken and difficult to examine. No traces of veins in the specimens seen. More perfect specimens must be had before this species can be considered as other than provisional.

Fragments of one or two other *Nitophylla* have reached me from the Pacific Coast, but not sufficiently perfect to warrant me in naming them.

Page 150, add,

5. *RHODYMENIA corallina*, Grev. (?); stipes cylindrical, sub-simple, expanding into a fan-shaped, many times dichotomous, rose-red frond; laciniae linear, with rounded

interstices and a flat, entire margin ; apices rounded ; conceptacles clustered near the ends of the laciniae, on the surface of the lamina ; tetraspores forming deep-red sori in the dilated apices. *J. Ag. Sp. Alg.* 2, p. 379. *Sphærococcus corallinus*, *Bory, Coq.* p. 175, t. 16. *Kütz. Sp. Alg.* p. 780.

HAB. San Diego, California, *Mr. A. D. Frye.* (v. s. in Herb. T.C.D.)

A single Californian specimen only has yet been seen, and I doubtfully refer it to *R. corallina*, in preference to founding a new species on such imperfect data. The frond is stipitate ; the stipes filiform, 2–3 inches long, then widening and passing into the cuneate base of a flabelliform, dichotomously parted lamina, with broadly linear or somewhat cuneate segments. The lower part of the stipes throws out 2 or 3 proliferous frondlets, and similar ones spring from the margin of the laciniae. The *conceptacles* are immersed in the ultimate segments of the laciniae, which then are truncated and foliiferous. The colour is a deep-red, and the substance rigid and membranaceous. Such is the Californian specimen, and it tolerably agrees with the Chilian species, whose character is given in the above diagnosis.

Page 175, add,

2* GIGARTINA *Chamissoi*, (?) Mont. ; *J. Ag. Sp. Alg.* 2, p. 267. *Sphærococcus Chamissoi*, *Ag. Ic. Med.* t. 6. *Mart. Ic. Sel. Bras.* t. 3, fig. 1.

HAB. West Coast, *Dr. Schott.*

A fragment of a *Gigartina*, closely allied to *G. Chamissoi*, if not a mere form of it, occurs in Dr. Schott's new Mexican collection. It is too imperfect for description. *G. Chamissoi* is a common species on the coast of Peru, and may very probably extend to the north of the Equator.

Page 180, add,

6. IRIDÆA *dichotoma*, Harv. ; stipes linear, compressed, simple or branched, passing into the cuneate base of the broadly cuneiform or obovate, repeatedly forked lamina ; laciniae shallow and rounded, divaricating, their margin entire or denticulate ; surface smooth and glossy. *I. micans*, var. *dichotoma*. *Hook. f. and Harv. Fl. Ant.* 2, p. 487. *I. dichotoma*, Harv. in *Hook. Journ.* 1845, p. 262.

HAB. California, *Mr. A. D. Frye.* (v. s.)

Stipes 1–2 inches long, about a line wide, throwing out 2–4 minutely stipitate fronds, which are 4–6 inches long, and 3–4 wide, at their greatest width. The base of the frond is cuneate, and the lobes into which it divides are also broadly cuneiform. They divaricate from each other, leaving very wide sinuses between. The frond is thus sometimes thrice forked, the last furcation being minute, and frequently a mere indentation. The substance is rather thin and membranous. The surface is smooth and glossy, and the colour a fine purple-red.

Whether a distinct species or a mere variety of *I. micans* remains to be shewn, when some competent observer on the Pacific Coast shall have properly examined the several reputed species of this most troublesome genus. If we admit more than *one* species it is difficult to refuse admission to many, the forms are so varied. The present is, at least, a well-marked *variety*.

Page 195, add,

4. HALOSACCION *dumontioides* ; stem short, filiform, emitting many crowded, tubular, membranaceous, long branches, which are quite simple, destitute of ramenta, and taper much to the base and apex.

HAB. Northumberland Sound, Queen's Channel, lat. 76° N., *Dr. Lyall*. (v. s. in Herb. T.C.D.)

Stem 1–3 inches long, simple or forked, filiform, about twice as thick as hog's bristle, emitting throughout its length, and directed towards all sides, numerous crowded, perfectly simple branches. *Branches* two feet long, more than quarter inch wide in the middle, cylindrical for their greater extent, but attenuated and fusiform to the base, and tapering at the extremity to an acute point, hollow, destitute of ramenta, smooth and glossy, formed of a very thin membrane. *Colour* a brownish pinky-red, partly discharged in fresh water. *Cellular* structure very dense.

I have some hesitation in proposing this as a species distinct from *H. ramentaceum* ; but if not a good species, it is at least a strongly marked variety, and has so much the external aspect of *Dumontia filiformis*, that until I had submitted a section to the microscope, I supposed I had before me a very luxuriant specimen of that plant. The microscopic structure of the membrane is that proper to *Halosaccion* (section *Halocelia*), but is not easy to see, as the collapsed cells do not readily expand on reimmersion of the dried frond. The substance is much softer and more membranous than in *H. ramentaceum*, and in drying the branches adhere much more strongly to paper. *Dr. Lyall* brought home several fine specimens.

Page 242, add,

16.* CALLITHAMNION *tenuis* ; filaments tufted, ultra-capillary, irregularly much branched, diffuse, flexuous, the branches and their divisions very generally secund, springing from the middle of the internodes; ramuli few and distant, patent, filiform, beset toward the attenuated apices with whorls of minute, byssoid fibres ; articulations cylindrical, those of the branches 4–6 times, those of the ramuli 3–4 times as long as broad, and gradually shorter towards the extremities. *Griffithsia tenuis*, *Ag. Sp. Alg.* p. 13. *J. Ag. Sp. Alg.* 2, p. 84. *Kütz. Sp. Alg.* p. 661.

HAB. Beesley's Point, New Jersey, *Mr. Samuel Ashmead*. (v. s. in Herb. T.C.D.)

Filaments 3–4 inches long, somewhat thicker than human hair, loosely tufted, flexuous, very irregularly branched, the ramification on a lateral, not a dichotomous

type. *Branches* usually secund, in some cases opposite or alternate, springing from the middle of the articulation (or internode), or from near its base (not from the shoulder), long and filiform, flexuous, furnished with several distant, secund, filiform, patent, secondary branches, which are either simple, or furnished with a few similar, secund ramuli. All the branches and ramuli of every grade spring from the middle of the internodes of the branches of the preceding grade. The ramuli taper to their summit; the last six or eight internodes are very short, or rather are gradually developed whilst the ramulus lengthens, and their nodes are beset, especially those of the younger ones, with whorls of minute and very delicate byssoid ramelli, which seem to be connected with the growing process; but perhaps may also accompany fructification, as they do in the nearly allied *C. thyrsoides*. The articulations are cylindrical, 4–5 times as long as broad, with a wide, hyaline margin and dissepiment, and are filled with rosy endochrome. *Substance* membranaceous and delicate. The frond closely adheres to paper in drying.

I have compared Mr. Ashmead's specimens with an authentic one of Agardh's *Griffithsia tenuis* from the Mediterranean, and find them to agree in every essential character; the only difference that I can perceive being, that the American specimens are larger and more luxuriant than the European. The fructification has not been observed either in America or Europe, and I may therefore be accused of indiscretion in removing this species from *Griffithsia* to the present genus. I do so because its affinity with *C. thyrsoides* of Ceylon and Australia is so great that they cannot be placed in separate genera; and the fruit of the latter is known. I only question whether I ought not to go a step further, and unite *C. thyrsoides* to *C. tenue* as a mere variety. Both are remarkable for the manner in which the branches and ramuli are inserted; and may be known by this character alone from all allied species. But there is no American species to which the present is nearly allied.

Page 247, under *Pikea californica*, add to the specific diagnosis,

(TAB. XLIX. B.)

And insert the following reference to the figure,

PLATE XLIX. B. *Fig. 1.* *PIKEA californica*, a robust specimen; and *fig. 2*, a more slender and smaller individual; both of the *natural size*. *Fig. 3.* Longitudinal section of the frond, showing the central, articulated axial filament, and the two strata of cells. *Fig. 4*, a transverse section of the frond; these two figures equally *magnified*.

No. 2. List of Arctic Algæ, chiefly compiled from collections brought home by Officers of the recent Searching Expeditions.

1. *FUCUS vesiculosus*, Linn. *Ner. Bor. Amer. part 1, p. 71.*
HAB. Common along the Arctic Seas, and continuing through Behring's Straits along the North-west Coast. Whalefish Islands, and north end of Disco, *Dr. Lyall.*
2. *FUCUS nodosus*, Linn. *Ner. Bor. Amer. part 1, p. 68.*
HAB. North end of Isle of Disco, *Dr. Lyall.*
3. *AGARUM Turneri*, Post. & Rup. *Ner. Bor. Amer. part 1, p. 95.*
HAB. Navy-board Inlet and Whalefish Islands, *Dr. Lyall.*
4. *LAMINARIA saccharina*, Lamour. *Ner. Bor. Amer. part 1, p. 92.*
HAB. Floating off the West Coast of Greenland, five miles from shore, in lat. 63, *Dr. Lyall.*
5. *ALARIA Pylaii*, Grev. *Ner. Bor. Amer. part 1, p. 89.*
HAB. Northumberland Sound, Queen's Channel, Lat. $76^{\circ} 52'$, *Dr. Lyall.*
6. *DESMARESTIA aculeata*, Lamour. *Ner. Bor. Amer. part 1, p. 78.*
HAB. Dredged in 6 fathoms, in Queen's Channel, lat. $76^{\circ} 29'$, long $96^{\circ} 13' W.$, *Dr. Lyall.*
7. *DICTYOSIPHON fœniculaceus*, Grev. *Ner. Bor. Amer. part 1, p. 114.*
HAB. Whalefish Islands, *Dr. Lyall.*
8. *CHORDARIA flagelliformis*, Ag. *Ner. Bor. Amer. part 1, p. 123.*
HAB. Whalefish Islands, *Dr. Lyall.*
9. *CHÆTOPTERIS plumosa*, Kütz. *Ner. Bor. Amer. part 1, p. 136.*
HAB. Arctic Coast, *Dr. Seeman.* Roots of large Algæ, floating near Whalefish Islands, *Dr. Lyall.*
10. *SPHACELARIA arctica*, Harv. *Ner. Bor. Amer. part 3, suppl. p. 124.*
HAB. Isle of Disco, *Dr. Lyall.*
11. *ECTOCARPUS fasciculatus*, Harv. *Ner. Bor. Amer. part 1, p. 141.*
HAB. Whalefish Islands, *Dr. Lyall.*
12. *ECTOCARPUS littoralis*, Lyngb. *Ner. Bor. Amer. part 1, p. 139.*
HAB. Whalefish Islands, *Dr. Lyall.*

13. RHODOMELA *lycopodioides*, Ag. *Ner. Bor. Amer. part 3, suppl. p. 126.*
HAB. Cast ashore on Disco and Whalefish Islands, *Dr. Lyall.*
14. RHODOMELA *gracilis*, Kütz. *Ner. Bor. Amer. part 2, p. 26.*
HAB. In rock-pools. Disco and Whalefish Islands, *Dr. Lyall.*
15. POLYSIPHONIA *urceolata*, Grev. *Ner. Bor. Amer. part 2, p. 31.*
HAB. Dredged in 10 fathoms, off Cape Cockburn, 75° N. 100° W., *Capt. M'Clintock.*
16. CORALLINA *officinalis*, L. *Ner. Bor. Amer. part 2, p. 83.*
HAB. Lively Harbour, Isle of Disco, *Dr. Lyall.*
17. DELESSERIA *sinuosa*, Ag. *Ner. Bor. Amer. part 2, p. 93.*
HAB. Off the Greenland Coast, *Dr. Lyall.* North Shore of Prince of Wales' Strait, *Sir R. McClure.* Cape Cockburn 75°, and Lowther Island 74°, *Capt. McClintock.*
18. EUTHORA *cristata*, J. Ag. *Ner. Bor. Amer. part 2, p. 150.*
HAB. Disco Island, *Dr. Lyall.*
19. RHODYMENIA *interrupta*, Grev. *Ner. Bor. Amer. part 2, p. 149.*
HAB. Arctic Sea, *Lieut. W. H. Griffiths, R.N.*
20. RHODYMENIA *palmata*, Grev. *Ner. Bor. Amer. part 2, p. 148.*
HAB. Queen's Channel, Northumberland Sound, 76° 52' N., *Dr. Lyall.*
21. HALOSACCION *ramentaceum*, J. Ag. *Ner. Bor. Amer. part 2, p. 194.*
HAB. Whalefish and Disco Islands, and in Queen's Channel, *Dr. Lyall.*
22. HALOSACCION *dumontioides*, Harv. *Ner. Bor. Amer. part 2, suppl. p. 130.*
HAB. Northumberland Sound, Lat. 76° N., *Dr. Lyall.*
23. KALLYMENIA *Pennyi*, Dickie. *Ner. Bor. Amer. 2, p. 172.*
HAB. Dredged in 15–20 fathoms in Assistance Bay, *Dr. Sutherland.* Dredged in 6 fathoms, Queen's Channel, Lat. 76° 29' N., Long. 96° 13', *Dr. Lyall.*
24. Ptilota *serrata*, Kütz. *Ner. Bor. Amer. 2, p. 222.*
HAB. Arctic Coast, *Sir J. Richardson.* Whalefish Islands and West Coast of Greenland, *Dr. Lyall.*
25. Ptilota *plumosa*, Ag. *Ner. Bor. Amer. 2, p. 224.*
HAB. Arctic Sea Coast, *Sir J. Richardson.*
26. CLADOPHORA *arcta*, Kütz. *Ner. Bor. Amer. 3, p. 75.*
HAB. Whalefish Island, Davis's Straits, *Dr. Lyall.*
27. CLADOPHORA *rupestris*, Kütz. *Ner. Bor. Amer. 3, p. 74.*
HAB. Whalefish Islands, Davis's Straits, *Dr. Lyall.* Fiskernaes, near Cape Farewell, *Dr. Sutherland.*

28. CHÆTOMORPHA *Melagonium*, Kütz. *Ner. Bor. Amer.* 3, p. 85.
HAB. Roots of large Algæ, Whalefish Islands, *Dr. Lyall*.
29. CHÆTOMORPHA *Piquotiana*, Mont. *Ner. Bor. Amer.* 3, p. 85.
HAB. Floating in the sea, near Whalefish Islands, Davis's Straits, *Dr. Lyall*. (A single filament only !)
30. HORMOTRICHUM *Carmichaelii*, Harv. *Ner. Bor. Amer.* 3, p. 90.
HAB. Wellington Channell, *Dr. Lyall*.
31. HORMOTRICHUM *boreale*, Harv. *Ner. Bor. Amer.* 3, p. 90.
HAB. Whalefish Islands, *Dr. Lyall*.
32. HORMOTRICHUM *Wormskioldii*, Kütz. *Ner. Bor. Amer.* 3, p. 91.
HAB. Dredged in 6 fathoms, in Queen's Channel, 76° 29' N., 96° 13' W., *Dr. Lyall*.
Coast of Greenland, *Lyngbye*.
33. MOUGEOTIA (*species innominata.*)
HAB. In fresh water. Isle of Disco, *Dr. Lyall*.
34. LYNGBYA *muralis*, var. *aquatica*. *Ner. Bor. Amer.* 3, p. 104.
HAB. In pools of fresh water, Whalefish Islands, *Dr. Lyall*.
35. ULVA *latissima*, L. *Ner. Bor. Amer.* 3, p. 59.
HAB. Isle of Disco, and dredged in Queen's Channel, *Dr. Lyall*.
36. ULVA *bullosa*, L. *Ner. Bor. Amer.* 3, p. 60.
HAB. In pools of fresh water, Whalefish Islands, *Dr. Lyall*.
37. ENTEROMORPHA *intestinalis*, Link. *Ner. Bor. Amer.* 3, p. 57.
HAB. Whalefish Island, *Dr. Lyall*. (Probably universally spread.)
38. OSCILLATORIA *corium*, Ag. *Harv. Man. Ed.* 1 p. 166.
HAB. On stones in a running stream. Wellington Channel, *Dr. Lyall*.
39. NOSTOC *arcticum*, Berk. *Ner. Bor. Amer.* 3, p. 113.
HAB. Assistance Bay, lat. 75° 40' N., *Dr. Sutherland*.
40. NOSTOC *verrucosum*, Vauch. *Ner. Bor. Amer.* 3, p. 114.
HAB. Pools of fresh water, Isle of Disco, and at Beechey Islands, *Dr. Lyall*.
41. NOSTOC *Sutherlandi*, Dickie. *Ner. Bor. Amer.* 3, p. 114.
HAB. Winter quarters, Baffin's Bay, *Dr. Sutherland*.
42. NOSTOC *microscopicum*, Carm. *Ner. Bor. Amer.* 3, p. 115.
HAB. Baffin's Bay, *Dr. Sutherland*.

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[The systematic names in capitals are those which are adopted. The names in *italic* indicate synonyms, whilst the vulgar names are in roman. The asterisks refer to the page of description.]

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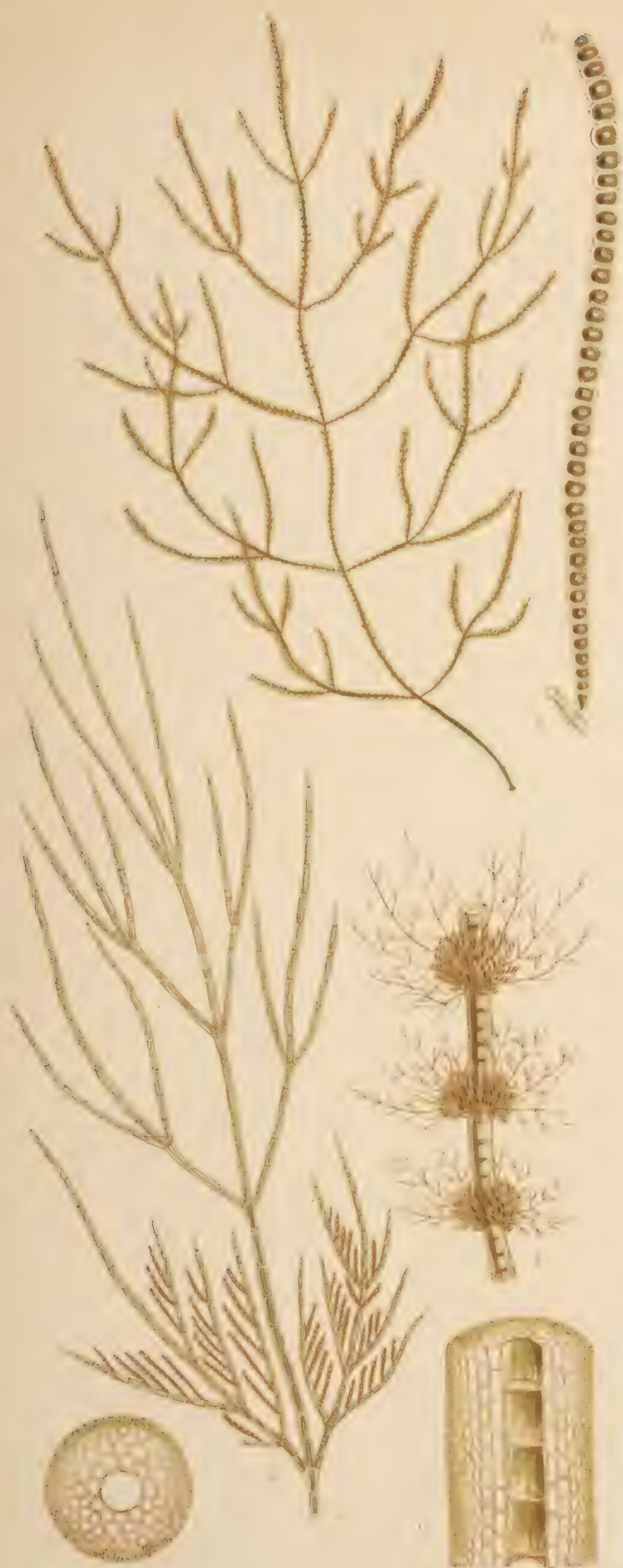
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PUBLISHED BY THE SMITHSONIAN INSTITUTION,
WASHINGTON CITY,
MARCH, 1858.







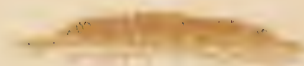
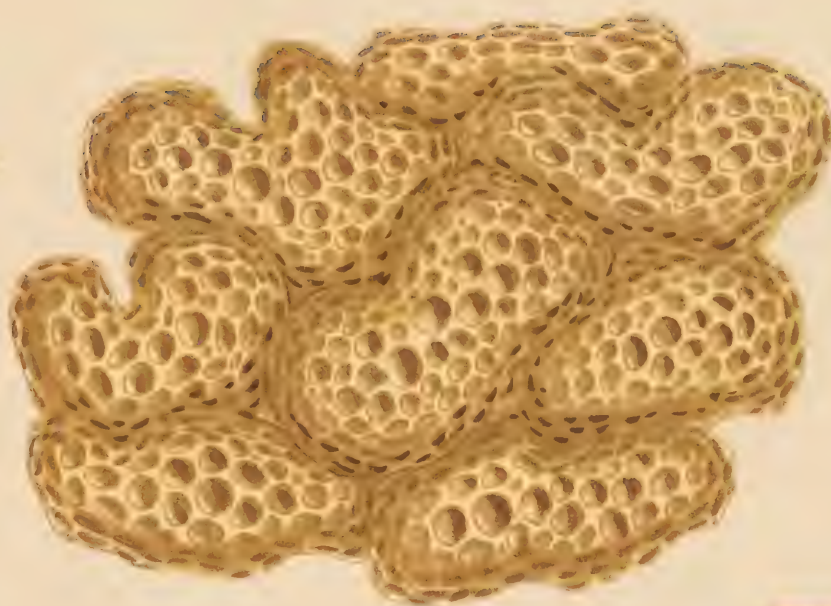


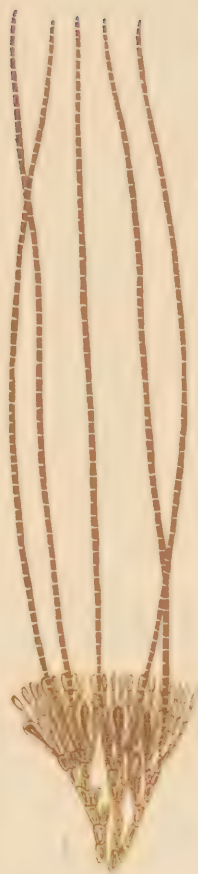
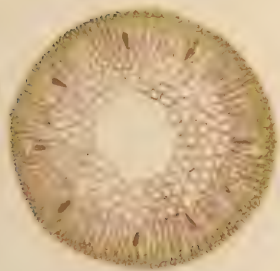
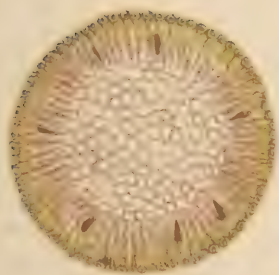
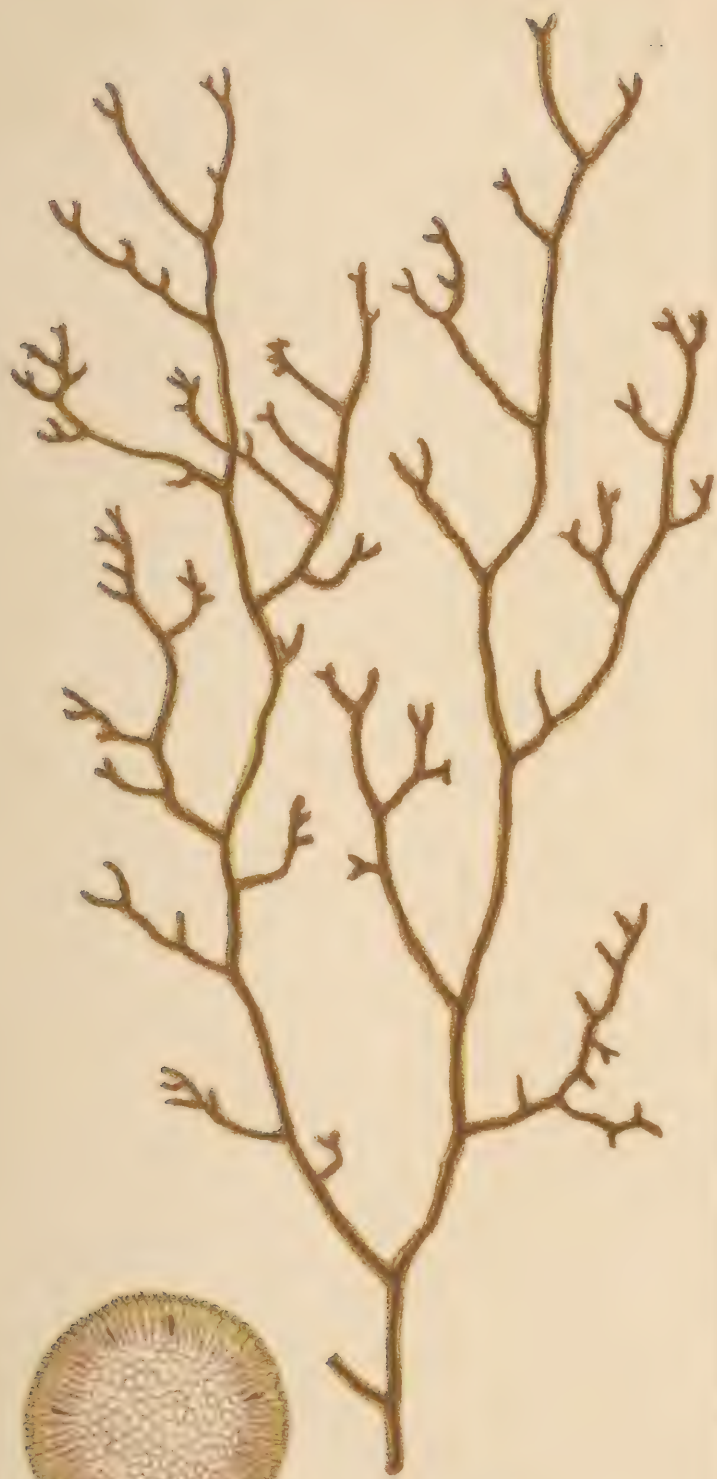




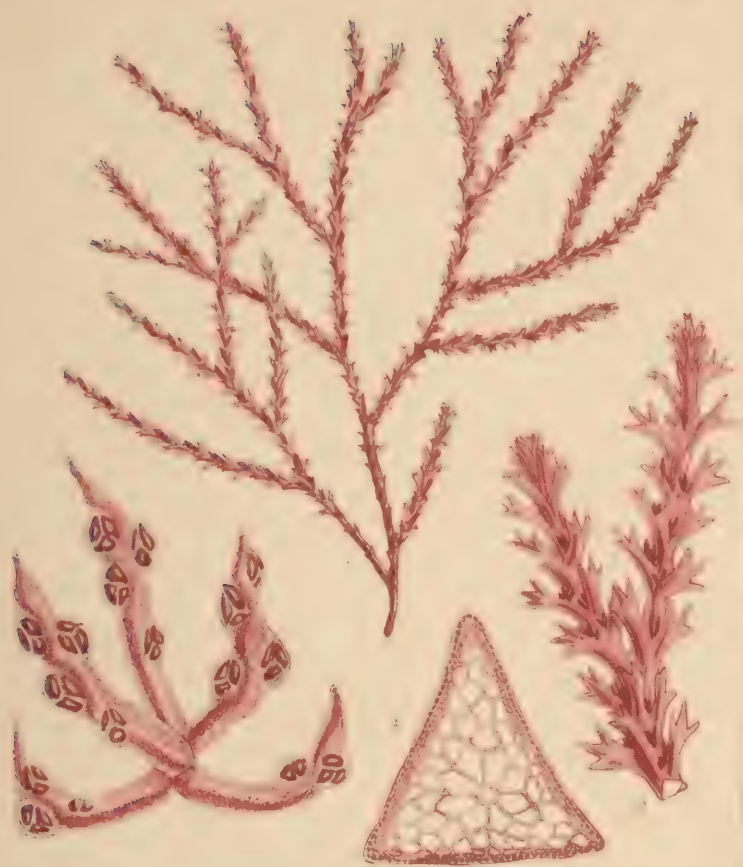






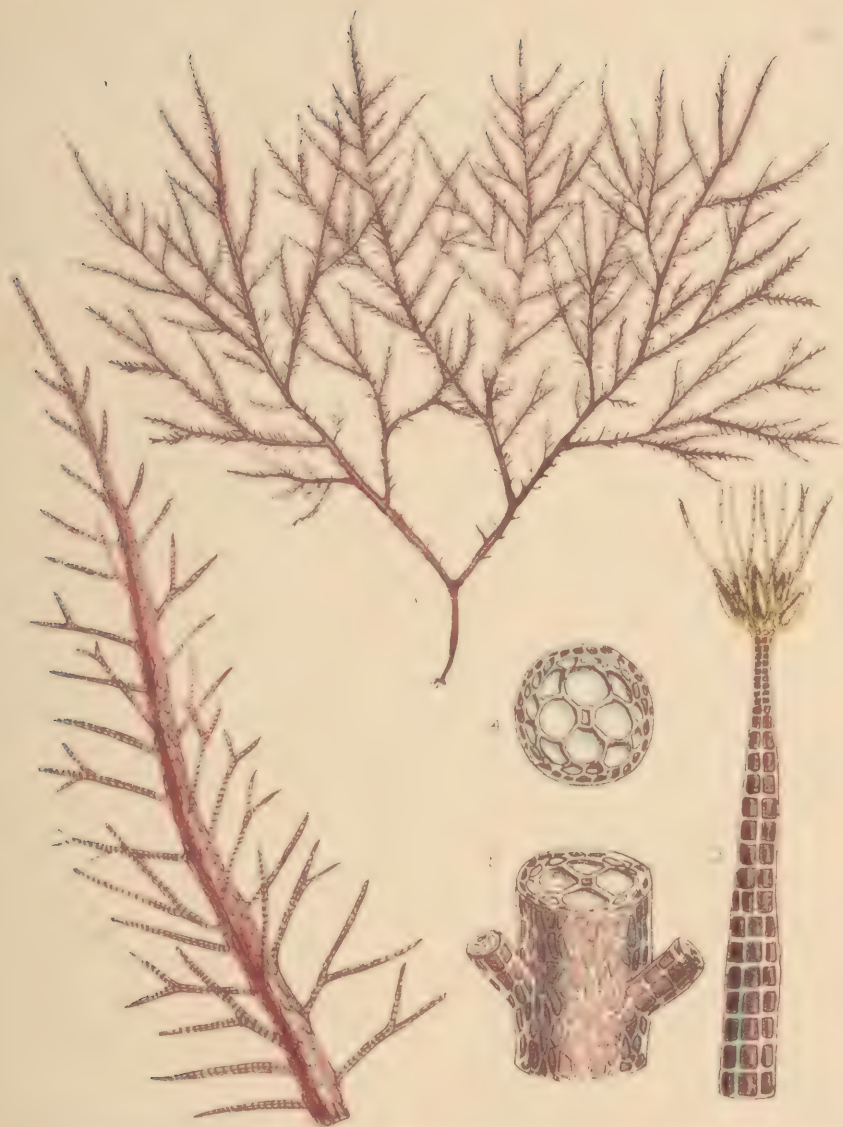






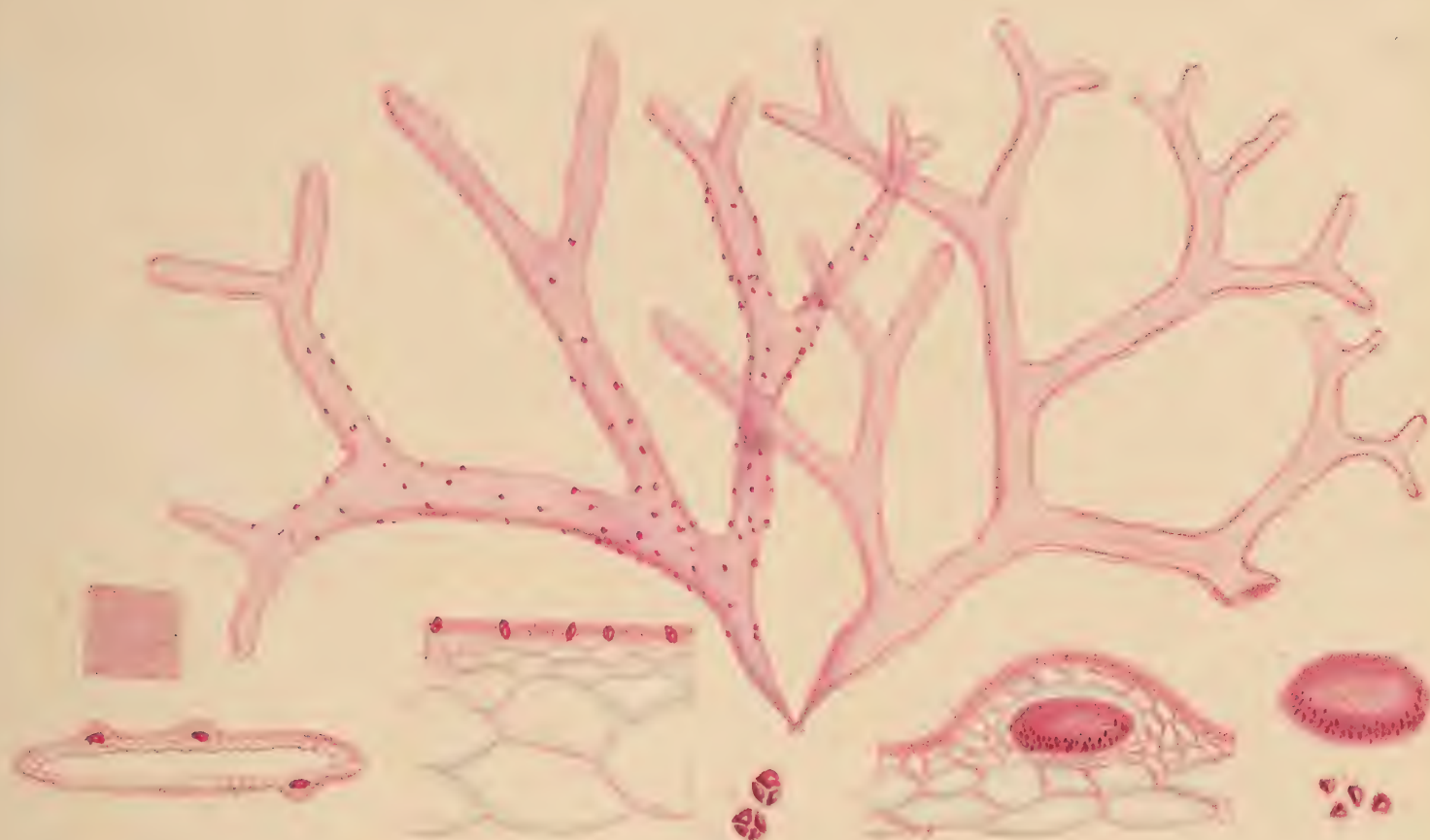










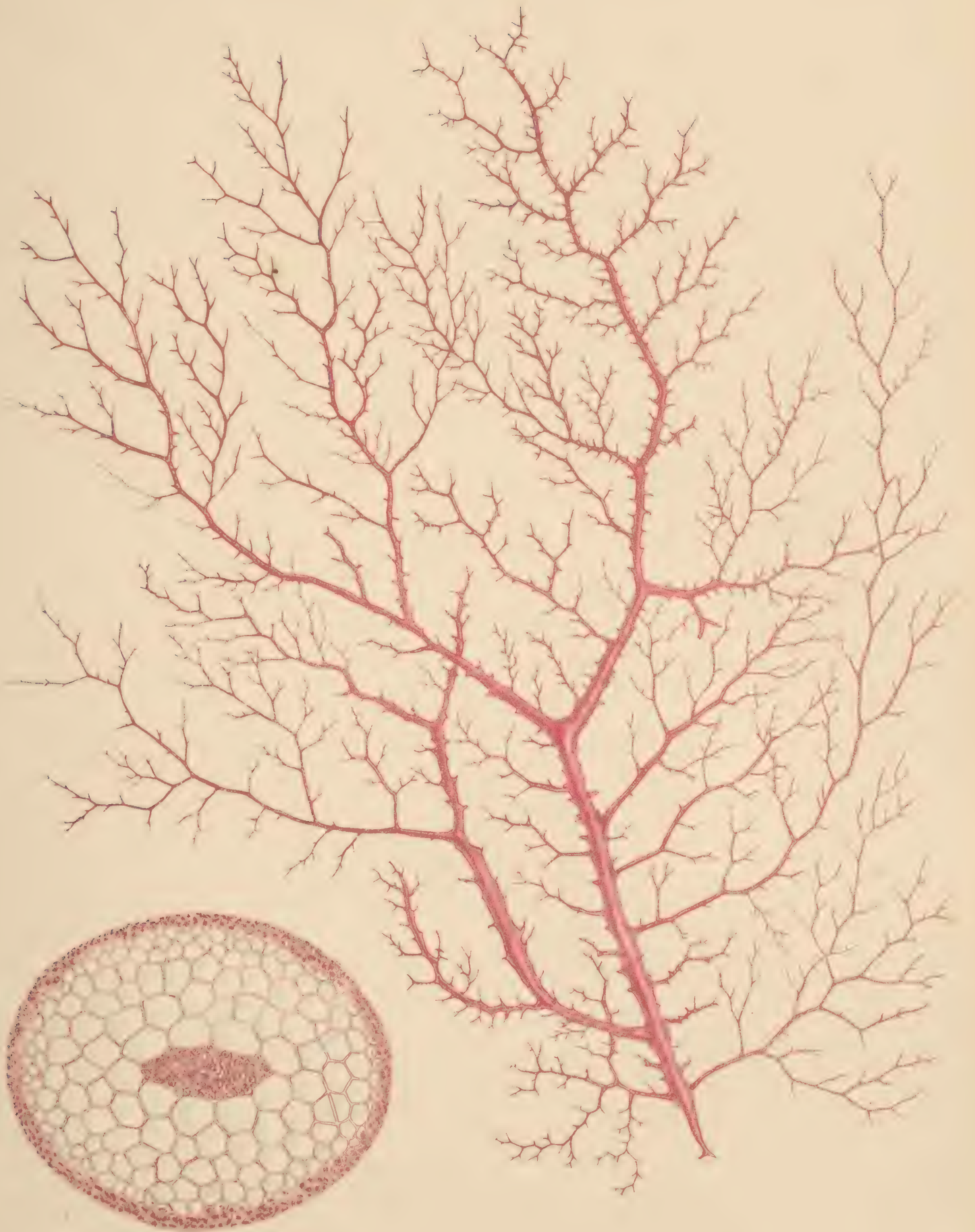






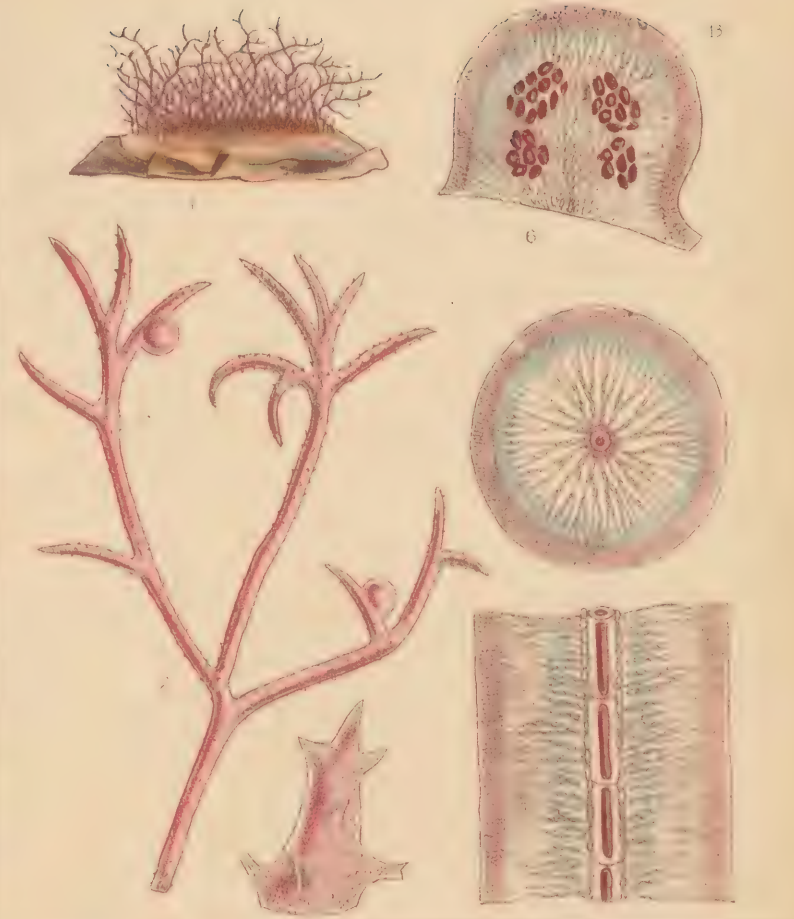






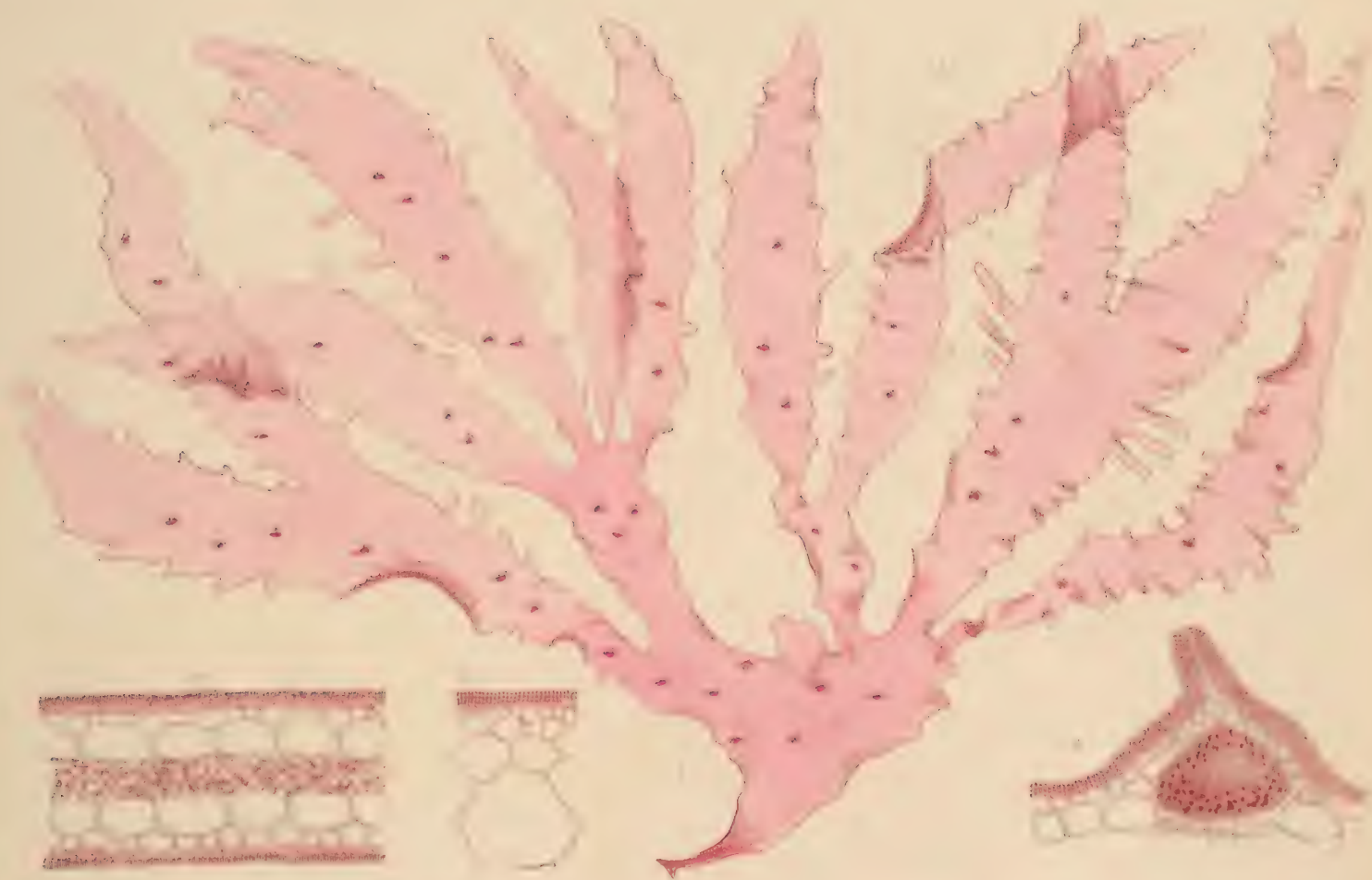










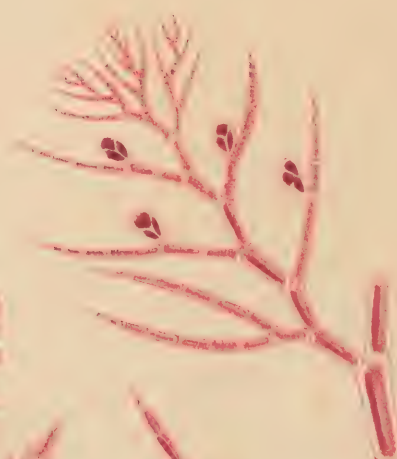




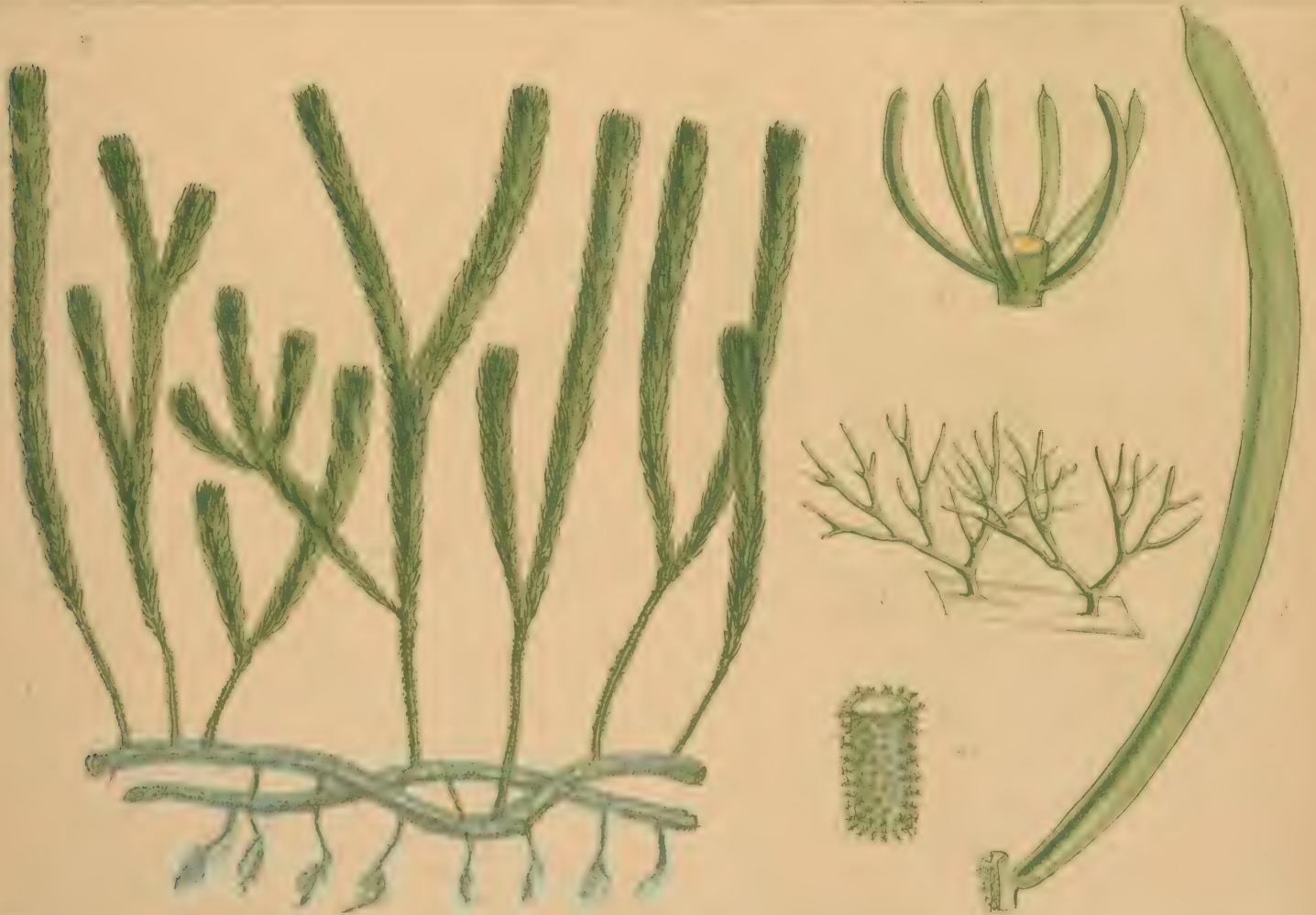




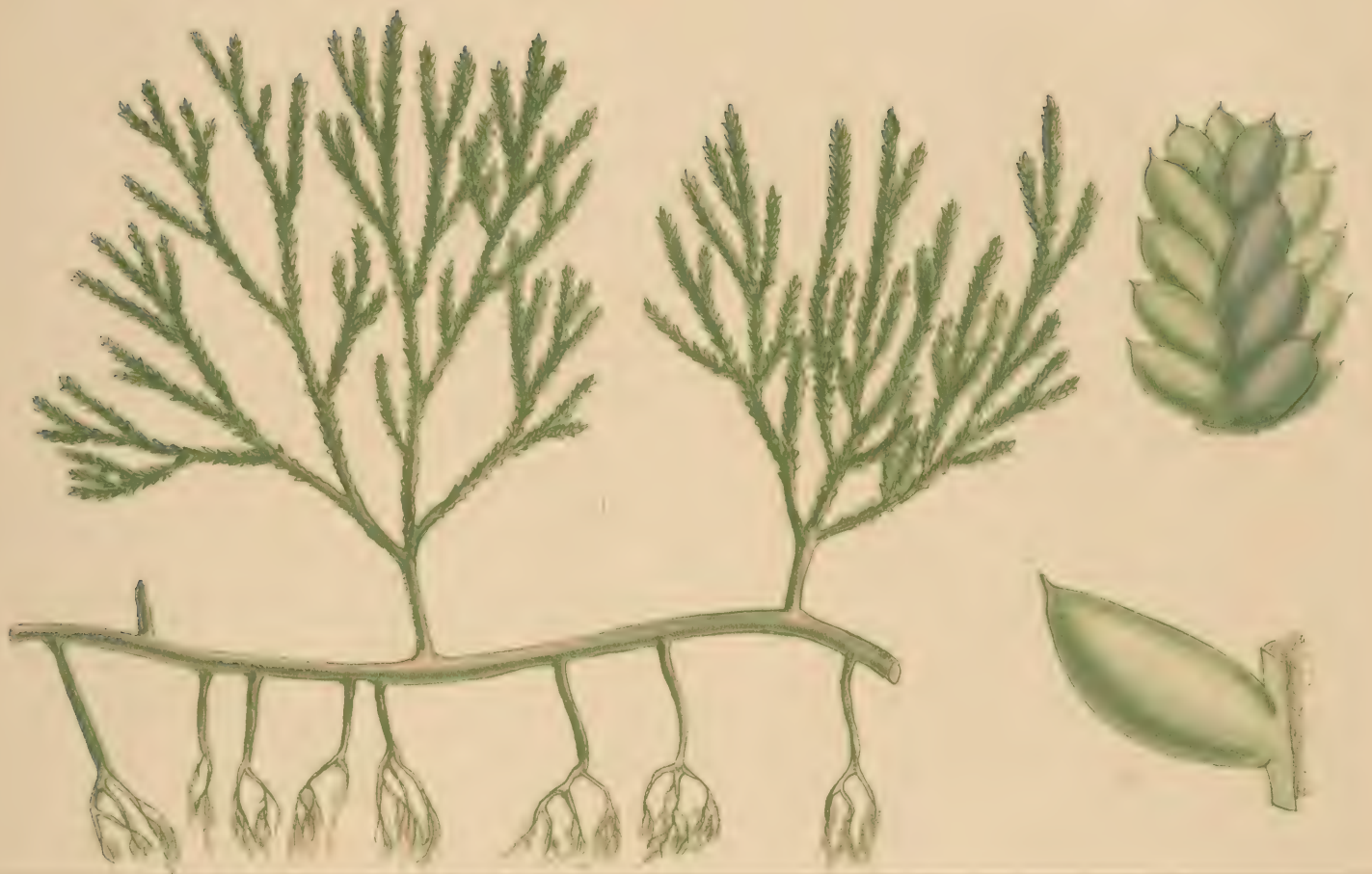


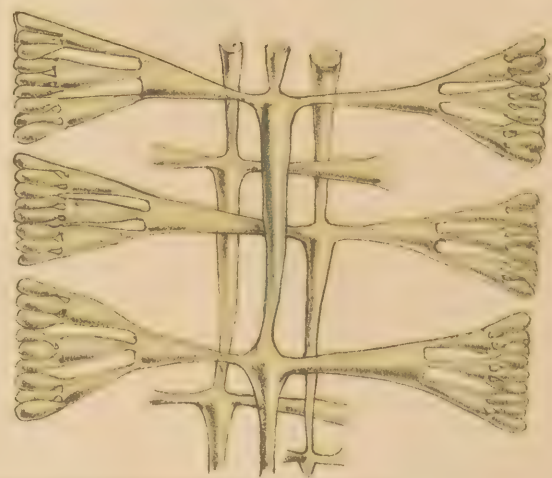
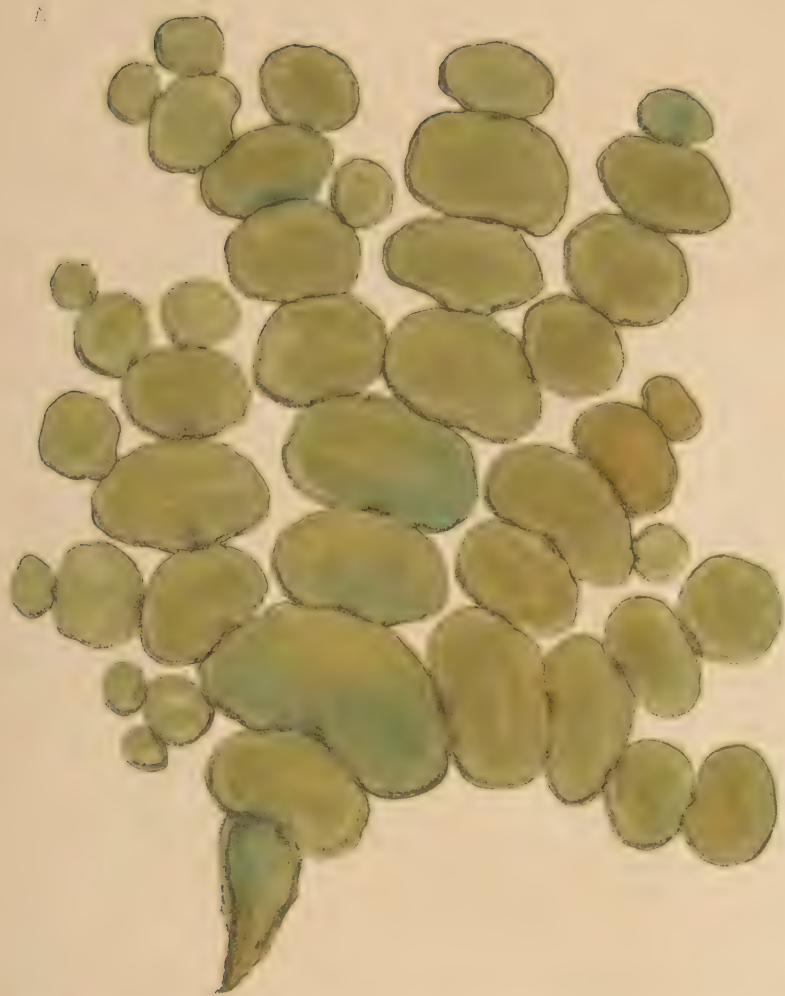




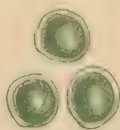
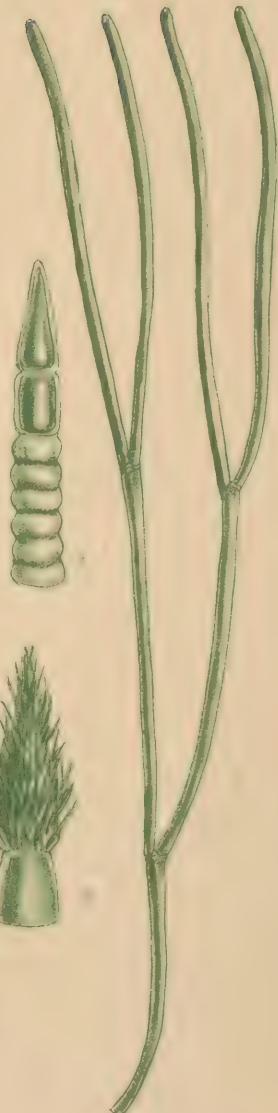
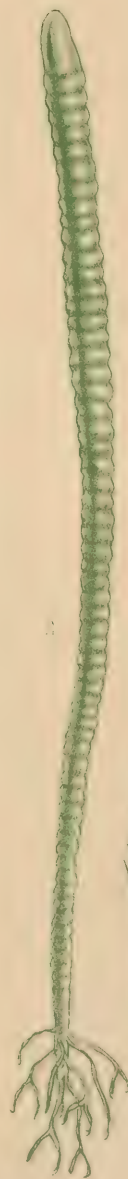
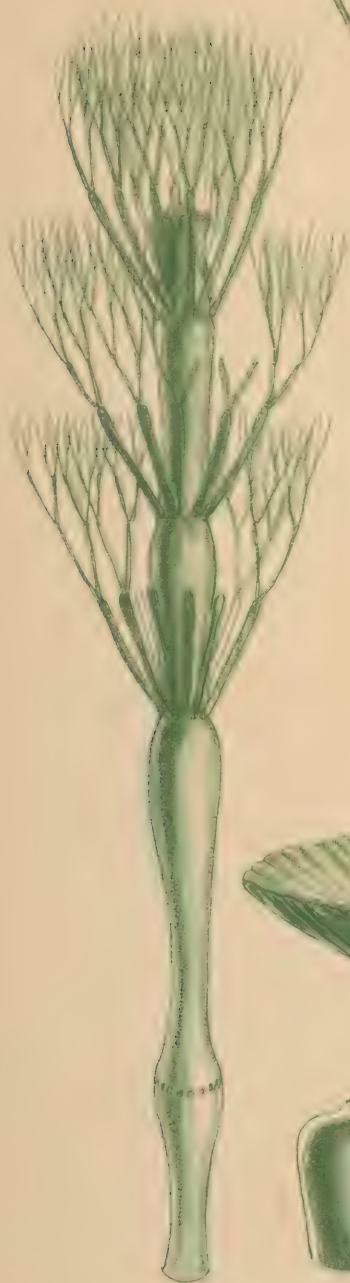




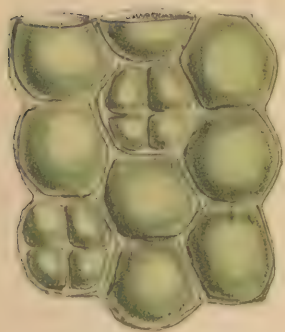
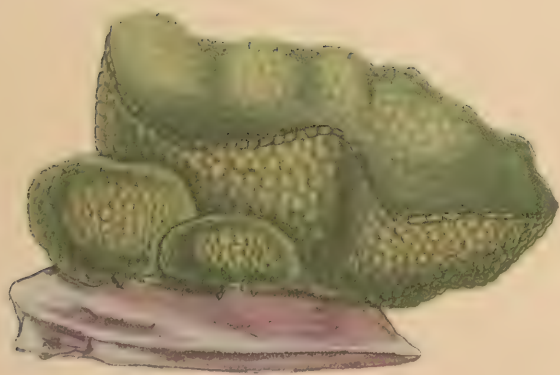




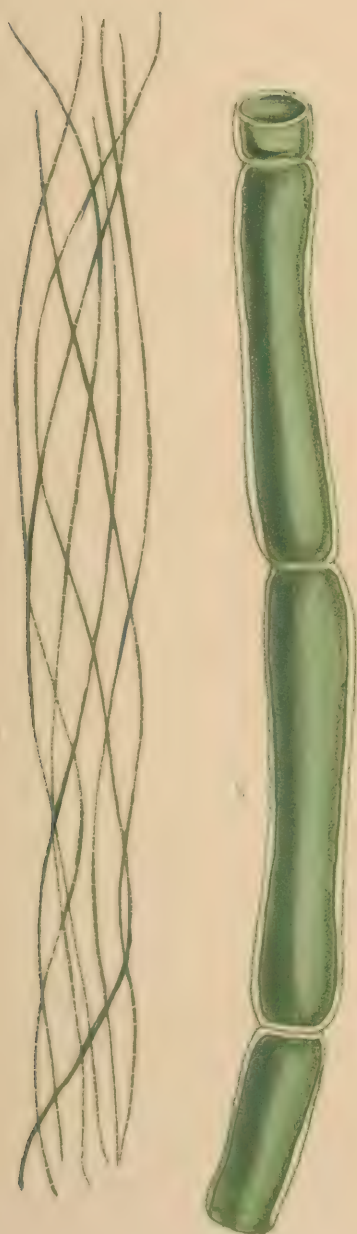
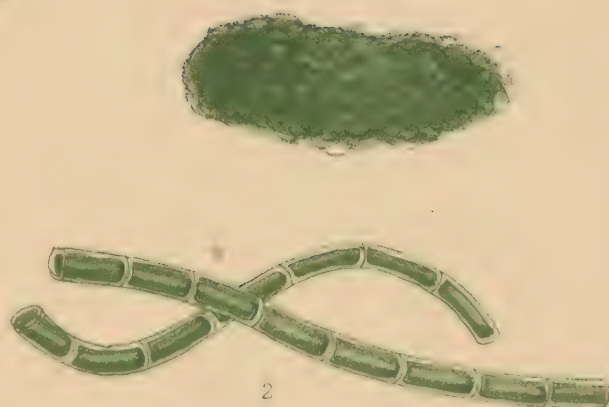
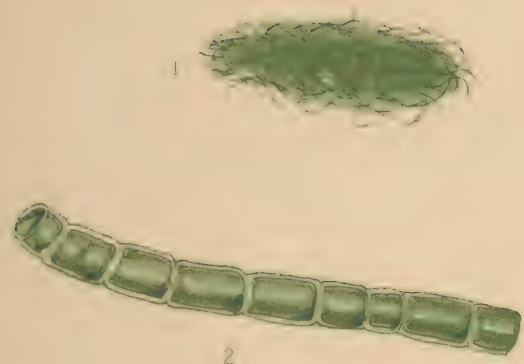




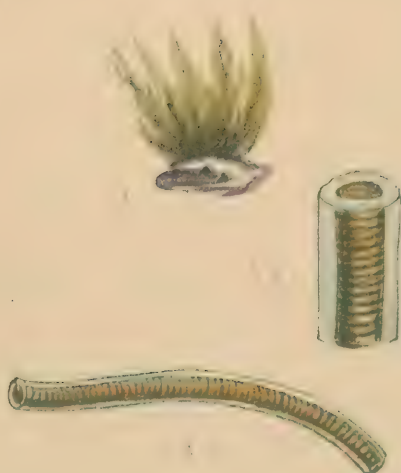
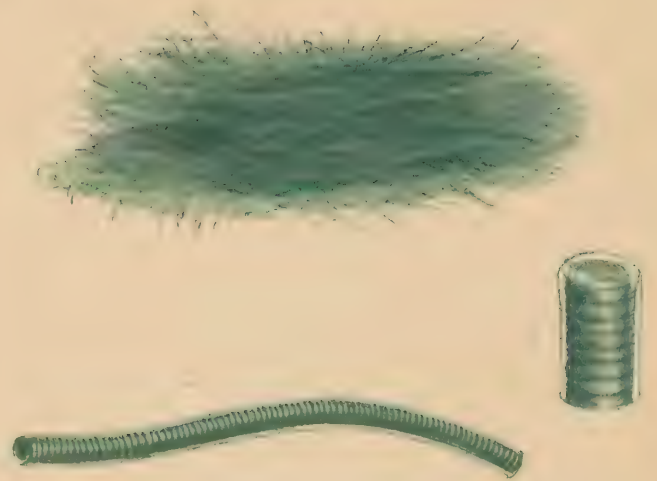


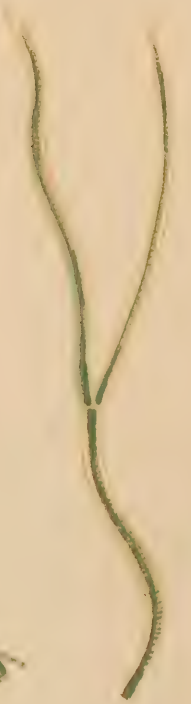
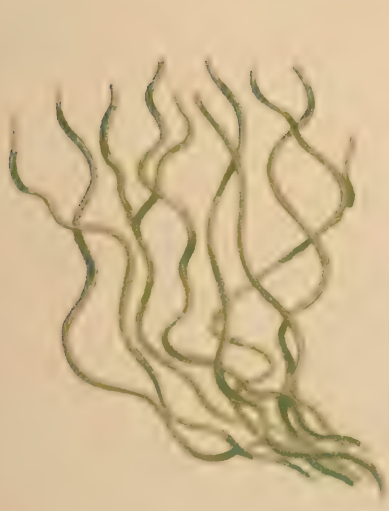
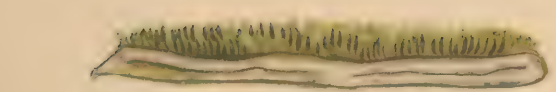


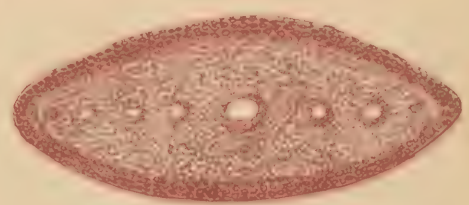
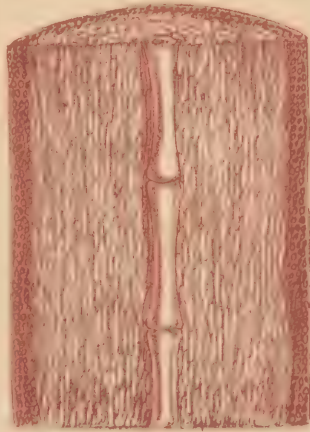
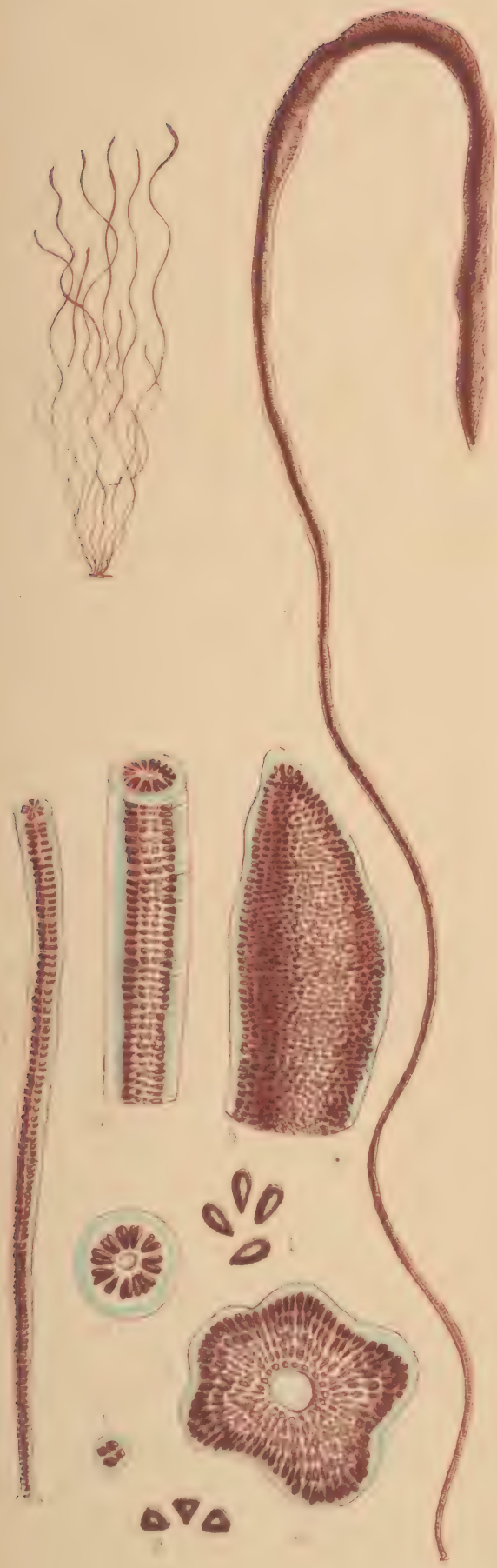




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